THE UNIVERSITY OF ALBERTA

MICROPALAEONTOLOGY OF THE DEER BAY FORMATION, ARCTIC ARCHIPELAGO, CANADA

A THESIS

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by

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ABSTRACT

Twenty-two arenaceous and 19 calcareous species of foraminifera are described and illustrated from the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island, and Isachsen, Ellef Ringnes Island, Northwest Territories, Canada.

Species described include: two species of Ammodiscus; one each of Ammodiscoides, Glomospira, Reophax, Verneuilinoides, Verneuilina, Tritaxia, Textularia, Astacolus, Vaginulina, Vaginulinopsis, Marginulinopsis, Globulina, Epistomina and Conorboides; three of Haplophragmoides, five of Ammobaculites and six of Trochammina; four each of Lenticulina and Saracenaria and two each of Dentalina and Nodosaria.

In addition 15 Mesozoic microspores, six Palaeozoic microspores, two Jurassic dinoflagellates and 2 hystrichosphaerids are briefly described and illustrated. One zone, characterized by Trochammina sp. A, is recognized in the Deer Bay Formation. This zone and the intervals containing the most abundant calcareous fauna have been correlated in the two localities. On the basis of microspores, dinoflagellates, hystrichosphaerids and megafauna the age of the Deer Bay Formation is Portlandian, or older, to Middle Neocomian. The position of the Jurassic-Cretaceous boundary within the formation has been approximated.

An alternative interpretation assuming regional diastrophism is presented.

The six Palaeozoic microspores indicate a southeasterly source for the Deer Bay Formation which was deposited in an inner to outer sublittoral fluctuating environment.

ACKNOWLEDGMENTS

The writer wishes to thank Dr. J.H. Wall, Dr. C.R. Stelck, Dr. P.S. Warren and Dr. S.J. Nelson of the Department of Geology, University of Alberta, for assistance and guidance in the preparation of this report.

J.C. Sproule and Associates Limited of Calgary permitted the writer to collect samples of the Deer Bay Formation at Buchanan Lake and kindly donated samples collected from this unit at Isachsen.

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David Grant and Frank Dimitrov prepared the plates and figures.

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INTRODUCTION

Purpose of project

The faunal succession across the Jurassic-Cretaceous boundary has interested geologists for many years. The purpose of this project is to study the microfaunal and microfloral assemblages in a Jurassic and Cretaceous marine sequence. The Deer Bay Formation of the Sverdrup Basin in the Arctic Archipelago is a black marine shale which contains Jurassic and Cretaceous foraminifera and microflora. It is the writer's intention to establish the age limits for the upper and lower levels of this formation and to indicate the probable position of the Jurassic-Cretaceous boundary within the exposed sections of the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island, and Isachsen, Ellef Ringnes Island.

Section locations

The two sections studied are located at Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island.

Buchanan Lake lies at the head of Mokka Fiord on eastern Axel Heiberg Island. The lake, approximately eight miles long, lies at right angles to the northwest-southeast regional strike of the Mesozoic and Tertiary rocks of which 22,000 feet are exposed dipping 20 degrees to the southwest. The Deer Bay Formation was measured and sampled along a creek about two miles southeast of the southwestern end of the lake. The section, 925 feet thick, is well exposed for the most part and the contacts with overlying and underlying formations are clearly visible (Fig. 2b). Except for Tertiary tilting the formation is

undeformed. Several diabase sills were intruded into the Mesozoic section during the Tertiary but these in no way affected the Deer Bay Formation at Buchanan Lake.

Isachsen is a weather station near the head of Deer Bay on western Ellef Ringnes Island. Here the Deer Bay Formation has its type section and only the upper 525 feet are exposed.

The formation is horizontally disposed and its contact with the overlying Isachsen formation is conformable and clearly visible. Numerous diabase sills and dykes have intruded the Deer Bay and Isachsen Formations but contact metamorphism is slight and limited in extent (Fig. 2a).

During the 1961 field season the writer, employed by J.C. Sproule and Associates Limited of Calgary, collected samples of the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island. The same formation at Isachsen, Ellef Ringnes Island, was studied by other geologists working for this organization.

History of exploration

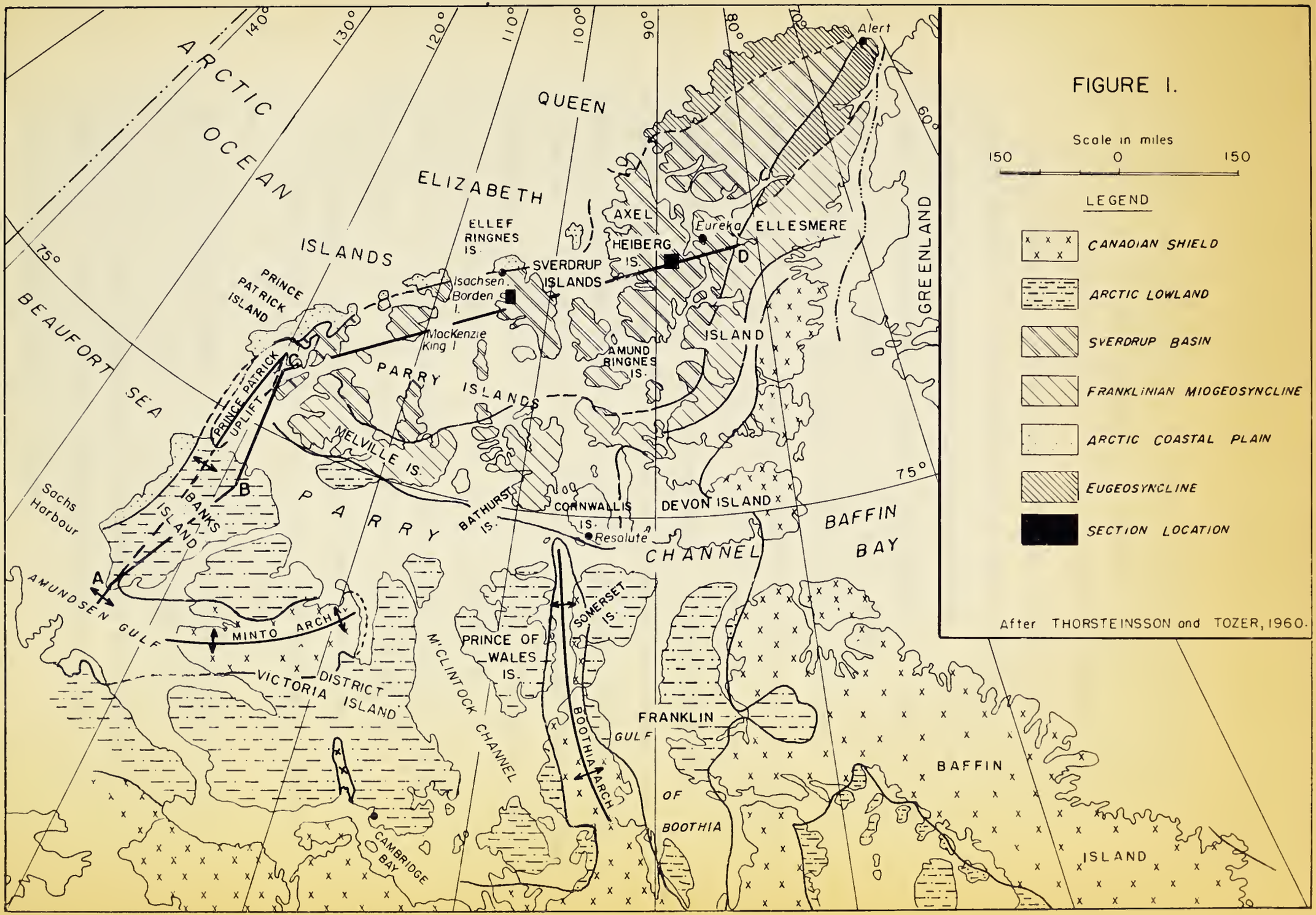
Sir Leopold M'Clintock, in 1853, was the first to find Jurassic fossils in the Canadian Arctic Islands. Per Schei, geologist of the Second Norwegian Expedition in the "Fram" (1898 - 1902), collected Triassic invertebrates and Tertiary plants from Ellesmere Island. For some forty years following the voyage of the "Fram", very little work was done on the Mesozoic and Tertiary rocks, although from 1906 to 1952 observations were made by Low, McMillan, Bentham and Troelson.

During the past ten years most of the work done in the Arctic Islands has been by the Geological Survey of Canada. Such men as Blackadar, Heywood, Christie, Tozer and Thorsteinsson have published several papers dealing with the geological features of this region.

Regional geology

Thorsteinsson and Tozer (1960) have divided the Arctic Archipelago into seven geologic provinces (Fig. 1). From southeast to northwest these are:

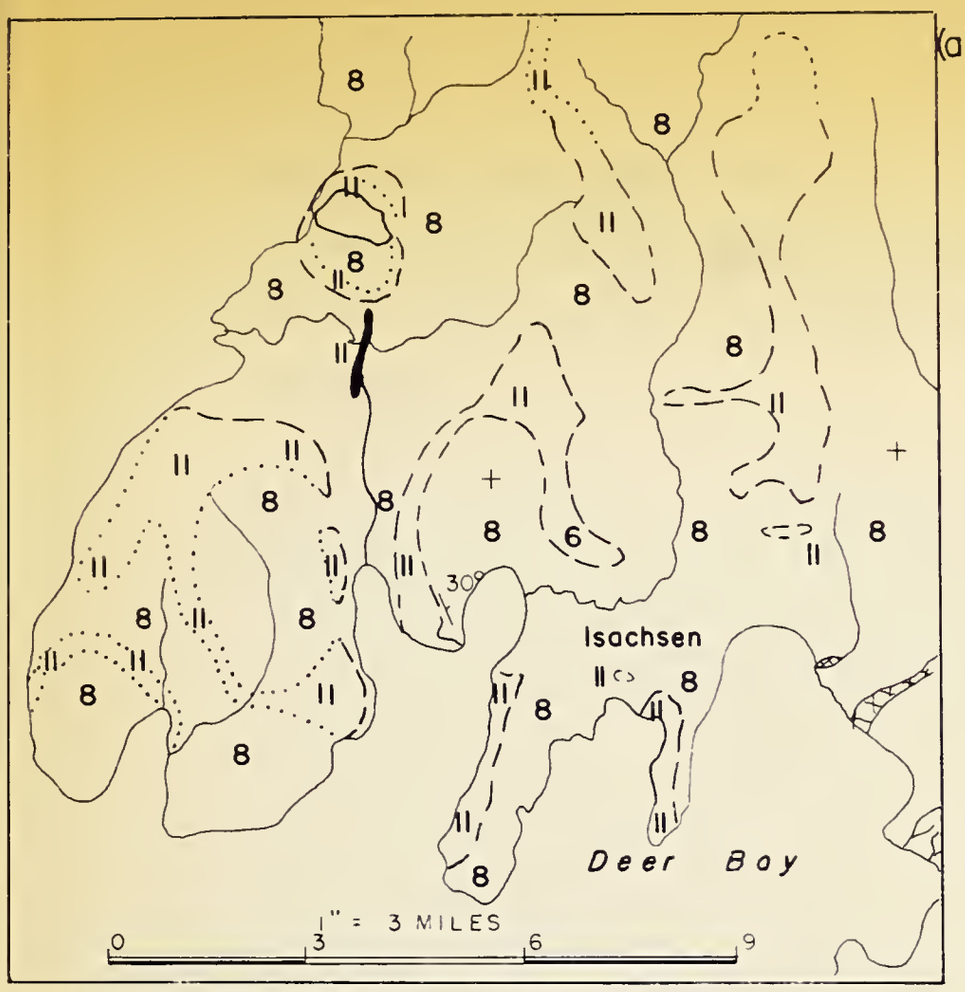
1. The Tertiary volcanic province: Young volcanic and sedimentary rocks occur on southeastern Baffin Island. This is outside of the area shown by Figure 1.
2. The Canadian Shield: Cratonic arches extend northward from the mainland exposing Precambrian rocks. These probably have been periodically active from early Palaeozoic time to the Tertiary period.
3. The Arctic Lowland: This is a region of thin, horizontal or gently dipping, Lower Palaeozoic strata that overlie Precambrian rocks. The former thicken northwards towards the Franklinian miogeosyncline. The Boothia Arch is a projection of the Canadian Shield which penetrates the Lowland along Boothia Peninsula and Somerset Island. It then disappears under the Parry Channel and is thought to underlie the folded rocks of Cornwallis Island. The Minto Arch on northwestern Victoria Island appears to be an inlier of Precambrian rocks. However, it also may be a projection of the craton extending northwestward through Victoria Island from Kent Peninsula.



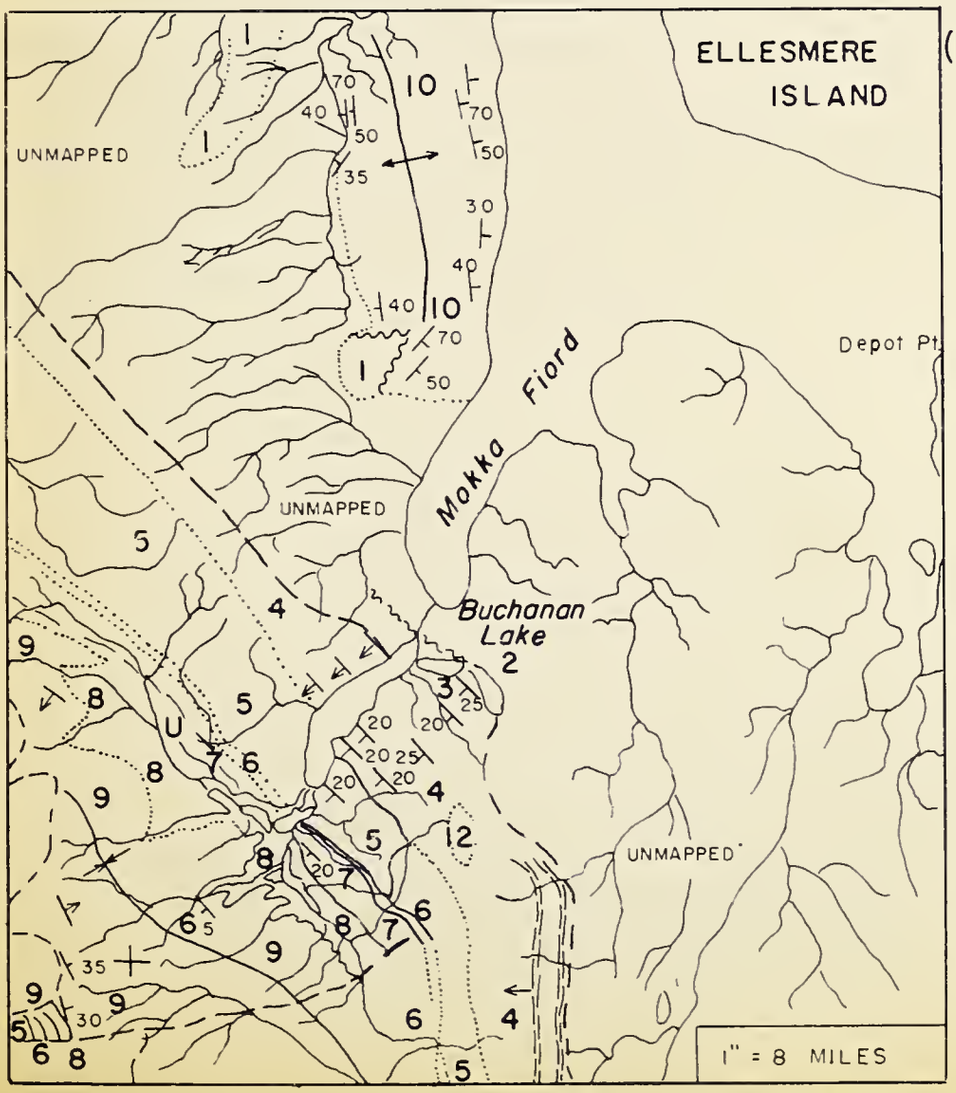
Regional Geology of the Arctic Islands Showing the Locations of the Buchanan Lake and Isachsen Sections. A – D = Profile Line of Figure 3.

4. The Franklinian Geosyncline: This area is known to have been one of subsidence from Cambrian to Upper Devonian time and is now the site of a long sinuous mountain belt. It extends easterly through the Parry Islands and northeasterly through Ellesmere Island. On northern Ellesmere Island eugeosynclinal rocks have been found to the northwest and southeast of the miogeosyncline. Two phases of Palaeozoic orogenesis have affected the geosyncline. The first, or "early Palaeozoic movements" took place between Upper Silurian and Lower Devonian time. The second, "mid Palaeozoic movements" occurred between the Upper Devonian and Middle Pennsylvanian epochs.
5. The Sverdrup Basin: This province, situated north and west of the exposed part of the Franklinian miogeosyncline, contains a thick sequence of Middle Pennsylvanian to early Tertiary sediments. An angular unconformity separates the beds in the basin from the folded Palaeozoic rocks of the miogeosyncline. The axis of the basin strikes northeasterly from Sabine Peninsula to northwestern Ellesmere Island. In the east and southeast, the beds thicken and dip towards the northwest and in the northwest, the beds are thin and dip towards the southeast. The southern and eastern margins of the basin suffered deformation between the Middle Pennsylvanian and Permian periods during what are referred to as the "late Palaeozoic movements."
6. The Prince Patrick Uplift: This province includes southern Prince Patrick Island and a small part of northern Banks Island. It consists of an isolated area of Devonian rocks that were upfaulted, perhaps in the form of horsts, during the Tertiary period. The causes of such upfaulting are unknown.

FIG. 2.



Location of ISACHSEN - section (after Heywood 1957)



Location of BUCHANAN LAKE - section (GSC map 36-1959)

LEGEND

12 Ice cap

TERTIARY

11 Basalt, diabase, gobbro

10 Undiferentiated

LOWER CRETACEOUS

9 Isochsen Formation - Sandstone, sond, shole, some corbonoceous shole, siltstone, conglomerate and coal, local agglomerate, non marine

LOWER CRETACEOUS - UPPER JUR.

8 Deer Bay Formation - shale, same calcareous mudstone, ferruginous-mudstane and sondstane; marine

UPPER JURASSIC

7 Awingak Formation - sandstane, in part non - morine, shale, marine

UPPER AND LOWER JUR.

6 Savik Formation - shale, calcareous mudstane; marine

LOWER JUR. (?) AND UPPER TRIA.

5 Heiberg Formation - sandstone, shales, marine beds in lower part

TRIASSIC

4 Bloo Mountoin Formation - block shale, siltstone; morine

3 Blind Fiard Formation - siltstone and silty shale

PERMIAN

2 shole, silty shale, siltstone; marine

1 Perma - Penn. - gypsum

F.D.

GEOLOGICAL BOUNDARY (APPROXIMATE, ASSUMED, KNOWN)

BEDDING (HORIZONTAL, INCLINED)

BEDDING TREND WITH DIRECTION OF DIP

FAULT

ANTICLINE, SYNCLINE

7. The Arctic Coastal Plain: This is a narrow strip of late Tertiary or Pleistocene sediments extending from Banks Island to Meighen Island. These beds rest unconformably on all older formations in this area.

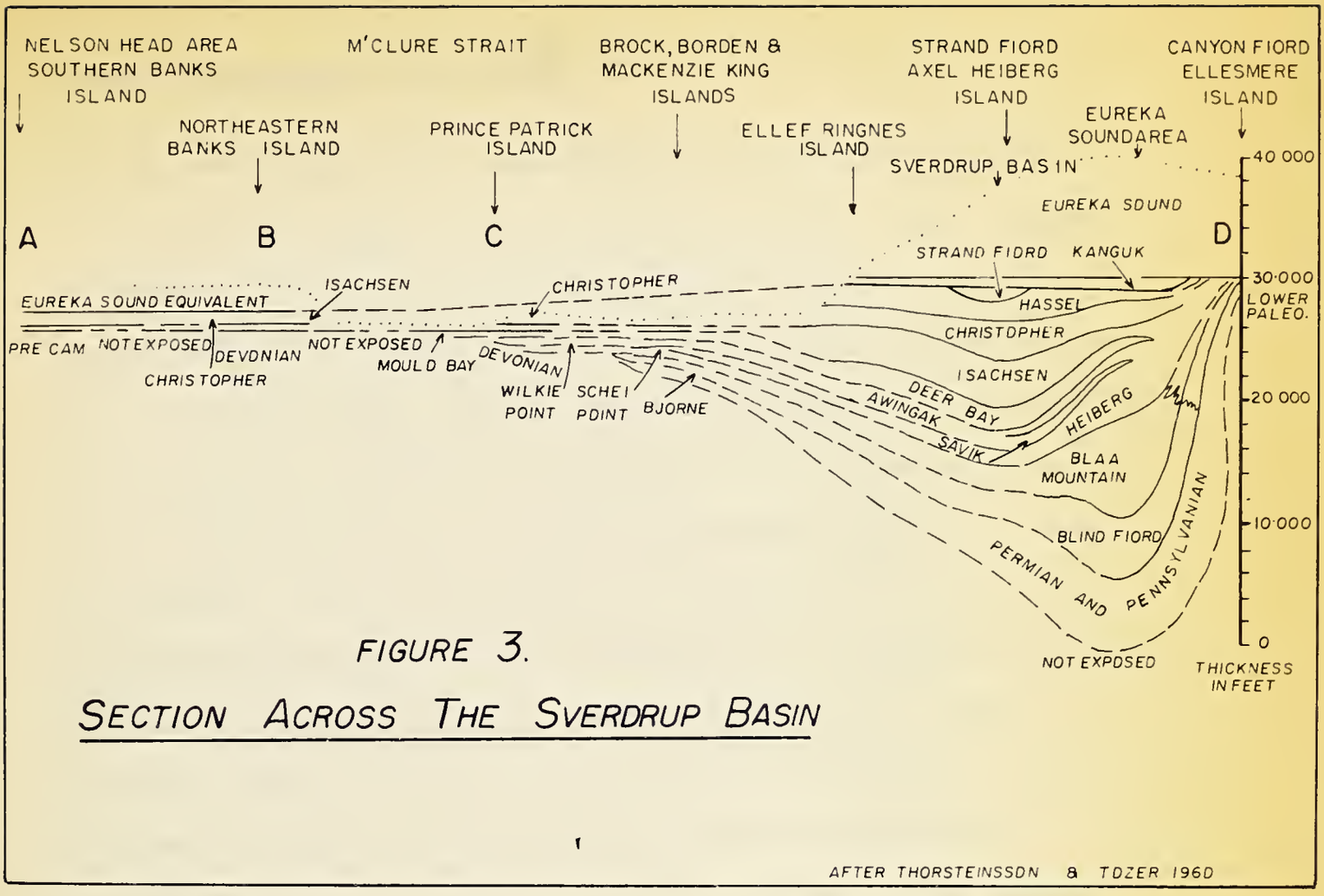


FIGURE 3.

SECTION ACROSS THE SVERDRUP BASIN

AFTER THORSTEINSSON & TOZER 1960

STRATIGRAPHY AND PALAEONTOLOGY

General stratigraphy and megafauna

The Deer Bay Formation lies within the Sverdrup basin and was deposited during Upper Jurassic and Lower Cretaceous time. The unit is a silty, black marine shale which attains maximum thickness of about 1,000 feet at Strand Fiord on southeastern Axel Heiberg Island. At all localities where exposed, the Deer Bay Formation is overlain by the continental Isachsen Formation (Fig. 3). The latter is a grey, fine- to medium-grained quartzose sandstone, with grains well sorted and rounded. In the lowermost beds of the Isachsen Formation there is a marine fauna characterized by Aucella cf. A. bulloides Lahusen and Aucella cf. A. terebratuloides Lahusen. These have been dated by Jeletzky (Heywood, 1957) as Infravalanginian to Valanginian. The continental Awingak Formation underlies the Deer Bay Formation. Although the former is mainly non marine, there are several marine beds within the sequence. On the basis of Amoeboceras sensu lato and Aucella, Frebold dated the Awingak as Lower Kimmeridgian or Oxfordian (Tozer, 1960).

Tozer (1960) described the Deer Bay Formation under the heading of "marine shale-siltstone facies." This facies is characteristic of the Mesozoic marine deposits of the axial part of the Sverdrup Basin. The Deer Bay Formation passes laterally into the arenaceous Mould Bay Formation on the margins of the basin.

Towards the end of Jurassic time, widespread subsidence ended the deposition of the continental Awingak sands and the marine Deer Bay Formation began to be laid down. At the margins of the basin the Mould

Bay sands were deposited and in both formations the oldest fossils known are of Portlandian age. These Portlandian faunules include Aucella fischeri (d'Orbigny) and Dorsoplanites sp. indet. (Frebold, 1958).

At Isachsen, where only the upper part of the Deer Bay Formation is exposed, Jeletzky has identified Aucella cf. terebratuloides Lahusen, Aucella ex. gr. keyserlingi (d'Orbigny), Aucella cf. nuciformis Pavlow, Aucella cf. werthii Pavlow, Aucella cf. crassa Pavlow, Acroteuthis ex. gr. subquadratus (Roemer) and an ammonite which is similar to the genera Dichotomites Koenen, Tollia Pavlow, and Neocraspedites Spath. From this fauna Jeletzky concluded that the Deer Bay Formation ranges in age from Infravalanginian to Valanginian (Heywood, 1957).

Following the deposition of the Deer Bay Formation, continental conditions gradually and progressively returned to the Sverdrup basin and the Isachsen Formation was deposited.

Jeletzky (1960) has correlated the Deer Bay Formation with the lower shale-siltstone division and the lower sandstone division of the Upper Jurassic-Lower Cretaceous section at the eastern flank of the Richardson Mountains (Fig. 4). On this basis the Deer Bay Formation in its lower part may be older than Portlandian. The upper levels of the formation are correlated with the Polyptychites (Polyptychites) cf. keyserlingi and Buchia cf. keyserlingi zone of the Valanginian.

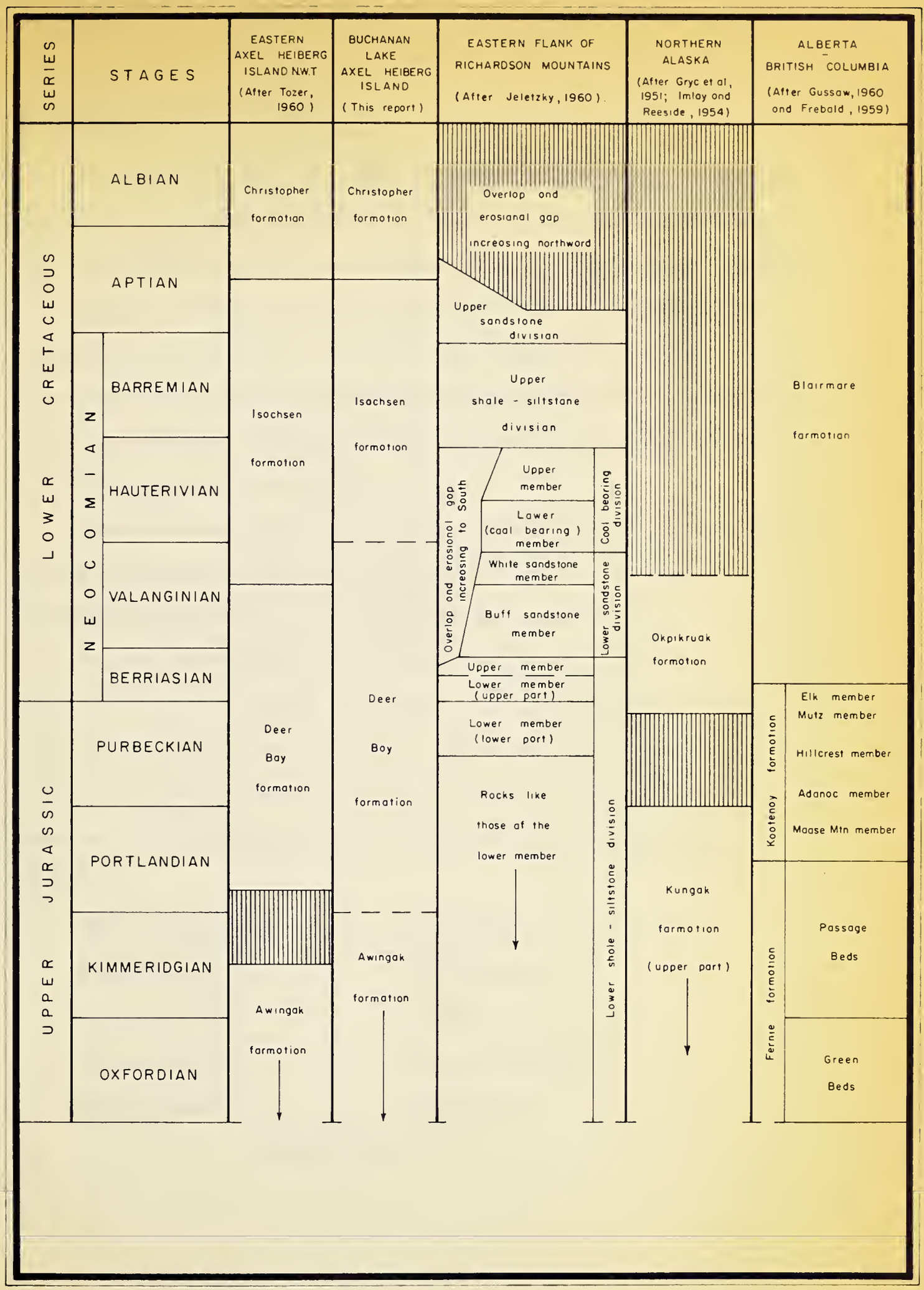


Figure 4. Correlation of Deer Bay Formation and Jurassic and Cretaceous Formations in Richardson Mountains, Northern Alaska and Southwestern Alberta.

General description of microfauna

A total of 23 arenaceous and 19 calcareous species of foraminifera are illustrated and described from the Deer Bay Formation of Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island, Northwest Territories. Arenaceous families are Ammodiscidae, Ashemonellidae, Lituolidae, Trochamminidae, Ataxophragmiidae and Textulariidae. The calcareous foraminifera are dominated by the Nodosariidae, 16 species being represented. One species each of Rotaliidae, Polymorphinidae and Discorbidae also is present.

Preservation is very poor at both localities and most specimens are highly distorted or broken. The arenaceous species and many of the calcareous forms have been silicified or pyritized or both.

Specimen abundance is very low and in many cases only one representative of a species was found. This prevented any precise zonation of the sections. In only a few instances were species restricted to definite intervals. In the Buchanan Lake and Isachsen sections of the Deer Bay Formation there are only 11 common types. These are:

Haplophragmoides sp. A	Trochammina sp. A
Haplophragmoides sp. B	Trochammina sp. B
Ammodiscus sp. A	Lenticulina sp. C
Ammobaculites sp. A	Verneuilinoides sp.
Ammobaculites sp. B	Globulina sp.
	Marginulinopsis sp.

Microfauna of the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island

Foraminifera found only in the Deer Bay Formation at Buchanan Lake include:

Reophax sp.	Astacolus sp.
Ammodiscus sp. B	Dentalina sp. A
Ammobaculites sp. C	Dentalina sp. B
Ammobaculites sp. D	Saracenaria sp. A
Ammobaculites sp. E	Saracenaria sp. B
Trochammina sp. C	Saracenaria sp. C
Lenticulina sp. A	Saracenaria sp. D
Lenticulina sp. B	Vaginulina sp.
Lenticulina sp. E	Vaginulinopsis sp.

Nodosaria sp. A

The arenaceous species occur throughout the formation and are more abundant than the calcareous forms. There are intervals within the formation in which some arenaceous types appear to be concentrated. Ammobaculites sp. A and A. sp. B are most abundant between 420 and 695 feet below the top of the Deer Bay Formation. However, each of these forms is common throughout. Trochammina sp. A is fairly restricted to an interval from 450 to 520 feet below the top of the formation, and T. sp. B is also common in this interval. Verneuilinoides sp. is most abundant in an interval from 480 to 490 feet.

Many of the arenaceous species are very large, for example Haplophragmoides sp. B, Reophax sp. and Ammobaculites sp. D, whereas others are extremely small such as some specimens of Ammodiscus sp. A

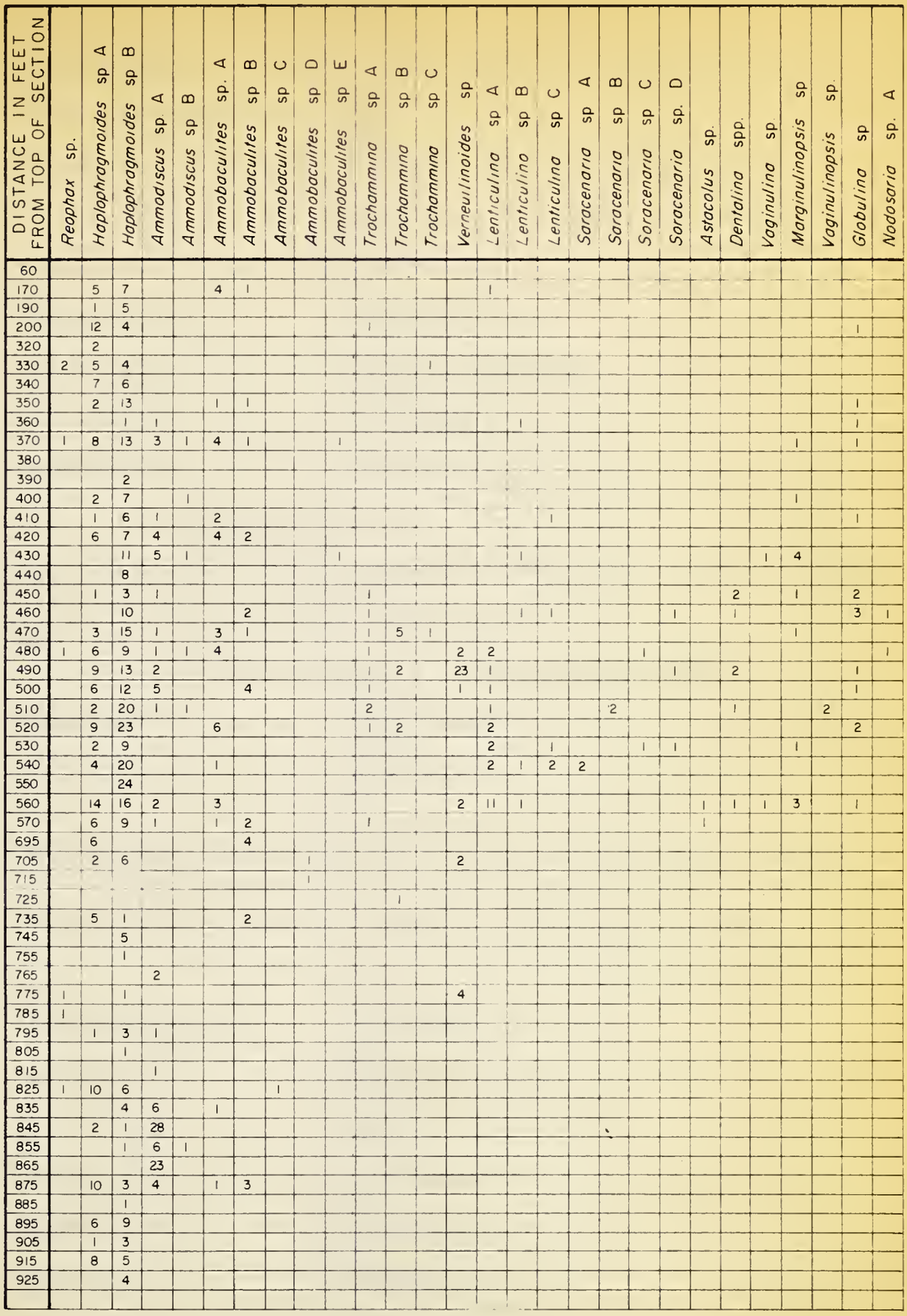


Figure 5. Stratigraphic Distribution of Jurassic and Cretaceous Foraminifera, Deer Bay Dormation, Axel Heiberg Island.

and Verneuilinoides sp. In a few cases there is a wide size variation, for example Ammodiscus sp. A.

The following calcareous foraminifera are most abundant in an interval from 430 to 570 feet below the top of the Deer Bay Formation and most of these belong to the Nodosariidae:

Lenticulina sp. A
Lenticulina sp. B
Lenticulina sp. C
Dentalina spp.
Saracenaria spp.
Marginulinopsis sp.
Globulina sp.
Nodosaria sp. A
Astacolus sp.

These may extend a little higher into the formation but a covered interval prevents the choice of a definite upper limit.

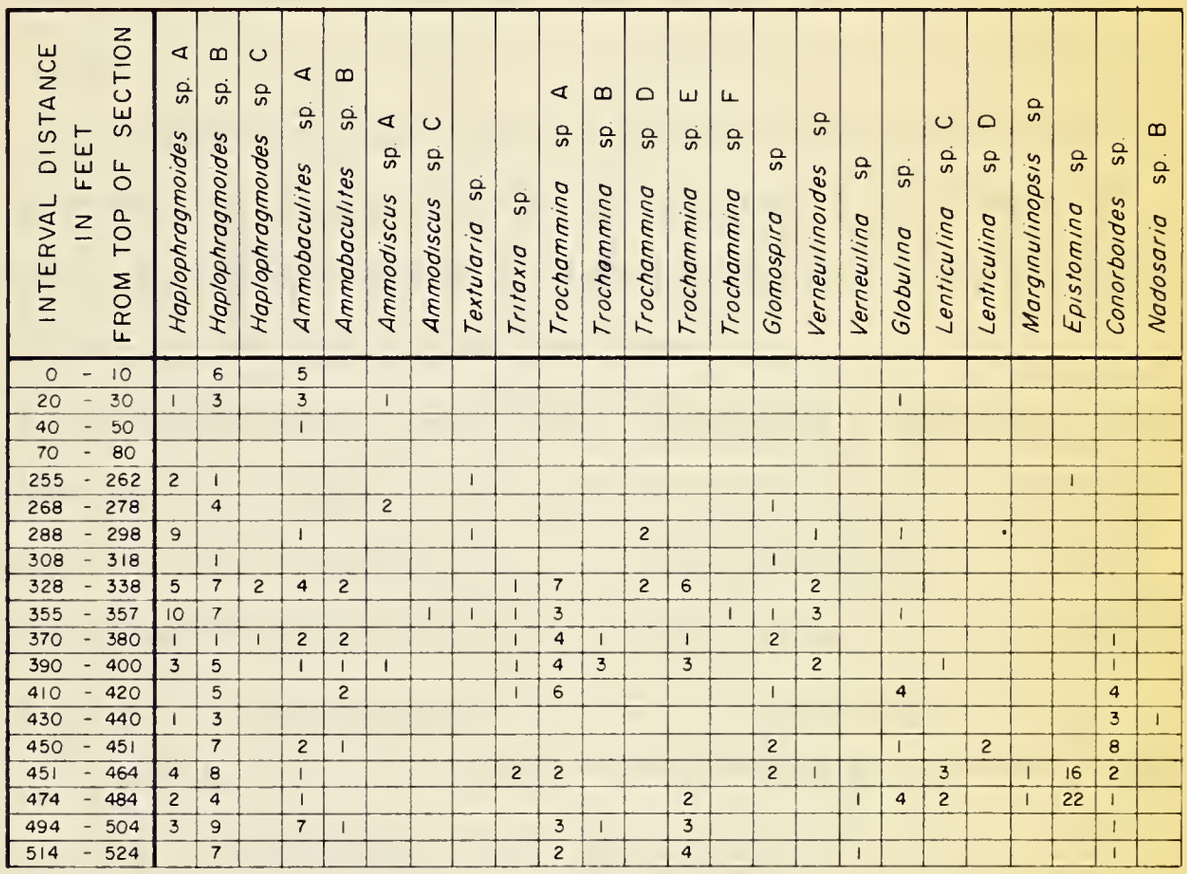
Some of the calcareous species are quite large, for example:

Lenticulina sp. C
Dentalina sp. A
Dentalina sp. B
Nodosaria sp. A

Microfauna of the Deer Bay Formation at Isachsen, Ellef Ringnes Island

Foraminifera found only in the Deer Bay Formation at Isachsen include:

Haplophragmoides sp. C
Textularia sp.
Tritaxia sp.
Trochammina sp. D
Trochammina sp. E
Trochammina sp. F
Glomospira sp.
Verneuilina sp.
Lenticulina sp. D
Epistomina sp.
Conorboides sp.
Nodosaria sp. B



INTERVAL DISTANCE IN FEET FROM TOP OF SECTION	*Haplophragmoides* sp. A	*Haplophragmoides* sp. B	*Haplophragmoides* sp C	*Ammobaculites* sp. A	*Ammobaculites* sp. B	*Ammodiscus* sp. A	*Ammodiscus* sp C	*Textularia* sp.	*Trritaxia* sp	*Trochammina* sp A	*Trochammina* sp. B	*Trochammina* sp D	*Trochammina* sp. E	*Trochammina* sp F	*Glomospira* sp	*Verneuilinoides* sp	*Verneuilina* sp	*Globulina* sp.	*Lenticulina* sp. C	*Lenticulina* sp D	*Marginulinopsis* sp	*Epistomina* sp	*Conorboides* sp.	*Nadosaria* sp. B
0 - 10		6		5																				
20 - 30	1	3		3		1												1						
40 - 50				1																				
70 - 80																								
255 - 262	2	1						1														1		
268 - 278		4				2									1									
288 - 298	9			1				1				2				1		1		•				
308 - 318		1													1									
328 - 338	5	7	2	4	2				1	7		2	6			2								
355 - 357	10	7					1	1	1	3				1	1	3		1						
370 - 380	1	1	1	2	2				1	4	1		1		2								1	
390 - 400	3	5		1	1	1			1	4	3		3			2			1				1	
410 - 420		5			2				1	6					1			4					4	
430 - 440	1	3																					3	1
450 - 451		7		2	1										2			1		2			8	
451 - 464	4	8		1					2	2					2	1			3		1	16	2	
474 - 484	2	4		1									2				1	4	2		1	22	1	
494 - 504	3	9		7	1					3	1		3										1	
514 - 524		7								2			4				1						1	

Figure 6. Stratigraphic Distribution of Jurassic and Cretaceous Foraminifera, Deer Bay Formation, Ellef Ringnes Island.

The arenaceous species occur throughout the formation and are more abundant than the calcareous forms. Like the Buchanan Lake section, there are intervals in which some arenaceous types are concentrated. Ammobaculites sp. B is most abundant in an interval from 328 to 420 feet below the top of the Deer Bay Formation. Tritaxia sp. is almost restricted to the same interval as is Trochammina sp. A. Other species of Trochammina are found within this interval but they also occur at other levels.

Generally the arenaceous species from the Deer Bay Formation at Isachsen are not as large as those at Buchanan Lake. For example, specimens of Haplophragmoides sp. B, Ammobaculites spp. and Trochammina spp. are smaller than those at Buchanan Lake.

The calcareous forms, although not as obviously restricted as they are at Buchanan Lake, appear to be abundant within certain intervals. Conorboides sp. occurs between 370 and 524 feet below the top of the formation and within this interval this species is most abundant between 410 and 464 feet. Epistomina sp., except for one specimen near the top, is restricted to and abundant in an interval from 451 to 484 feet.

Specimens of Conorboides sp. and Epistomina sp. are quite large but most other calcareous species are small.

Microflora from the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island

A total of 15 Mesozoic microspores, 6 Palaeozoic microspores, 2 dinoflagellates and 2 hystrichosphaerids are briefly described and illustrated from the Deer Bay Formation at Buchanan Lake, Axel Heiberg Island.

Specimen abundance is very low and preservation is generally poor in the nine intervals chosen for microfloral analysis. Three samples (835 to 825, 530 to 520 and 490 to 480 feet) were either completely barren or the specimens were so poorly preserved that positive identification was impossible.

Lower Cretaceous microspores and hystrichosphaerids were found in an interval from 170 to 410 feet below the top of the formation, and are listed below:

Ricciisporites convolutus Pocock

Appendicisporites tricornitatus Weyland and Greifelf

Trilobosporites apiverrucatus Couper

Chomotriletes sp. Naumova

Pilosisporites trichopapillosus (Thiergart)

Aequitriradites spinulosus Pocock

Hystrichosphaeridium tubiferum (Ehrenberg)

Trilobosporites canadensis Pocock

Concavisporites parkini Pocock

Trilobosporites bernissartensis (Delcourt and Sprumont)

Parvisaccites radiatus Couper

Osmundacites primarius (Wolf)

Upper Jurassic microspores and dinoflagellates were found in an interval from 560 to 570 feet below the top of the formation and are listed below:

Cingulatisporites floridus Balme

Scrinodium apatelum Cookson

Gonyaulax eumorpha Cookson and Eisenack

The following forms range from the Upper Jurassic to the Lower Cretaceous and were found in most of the samples which contained spores:

Gleicheniidites senonicus Ross

Concavisporites verrucosus Delcourt and Sprumont

Cicatricosisporites dorogensis Patonie and Gelletich

Micrhystridium sp. Deflandre

In using microspores and other plant organisms for correlation purposes, one must obtain a statistical count of the species present. In this report the microspores and dinoflagellates were used only as an aid for correlation and thus a population count was not obtained.

Palaeozoic spores were found throughout the formation and are illustrated on plate 7. The figured specimens are well preserved and indicate that at least part of the formation was derived from pre-existing Upper Palaeozoic rocks, probably to the southeast. Dr. F.L. Staplin (personal communication) considers that microspores can withstand reworking because "objects in this size range, particularly when undergoing subaqueous erosion and transport, are insulated from abrasion by physical means." In addition, Mr. C. Singh (personal communication) accounts for their presence in later sequences because their exine is much thicker and more resistant than their Mesozoic counterparts.

The following is a list of the illustrated Palaeozoic spores:

Triquitrites cf. T. batillatus Hughes and Playford

Knoxisporites sp. Potonie and Kremp

Endosporites sp. Wilson and Coe

Densosporites sp. Berry

Cirratriradites sp. Wilson and Coe

Archaeotriletes sp. Naumova

The Paleozoic age of the microspores was determined by comparing them with similar species found in rocks of known Palaeozoic age.

Age and correlation

Tozer (1960) has used the Portlandian as the uppermost stage of the Jurassic System. In this report, the writer considers the Purbeckian to represent the uppermost Jurassic because at its type section in England, the continental Purbeck beds are seen to overlie the Portlandian sequence. Many of the spores of the Deer Bay Formation were compared with those found in the Upper Jurassic Purbeck beds on the south side of the London-Ardennes ridge.

During the early stages of research it was realized that the foraminifera alone would be of little use in determining the upper and lower age limits of the formation nor would they determine the position of the Jurassic-Cretaceous boundary within the sequence. The foraminifera were found to be long-ranging and generally more indicative of a Jurassic age for the whole formation. Correlation on the basis of foraminifera with any known Jurassic-Cretaceous section proved impossible because of the following reasons:

1. Preservation of the foraminifera within the Deer Bay Formation at each locality is generally very poor.
2. The majority of specimens described appear to be representatives of new species.
3. The number of specimens is very low, thus preventing precise zonation and comparison with other localities.
4. The foraminiferal suite at Buchanan Lake largely differs from that at Isachsen.

Because the deposition of microspores and dinoflagellates is less dependent upon environment, the writer decided to extract as many of these as possible from the nine chosen intervals to aid in the establishment of the age of the Deer Bay Formation.

Assuming that the palaeoclimates of Europe and the Arctic were essentially the same during the Upper Jurassic and Lower Cretaceous, one can expect the flora of the two regions to be closely related. Therefore, the microspores in the Deer Bay Formation were compared with forms in the Upper Jurassic, Wealden and Neocomian of England, continental Europe and Russia. With the use of unpublished information made available by Pocock, some species were compared with those found in the Lower Mannville Group of Alberta. The planktonic dinoflagellates were compared with similar species from Australia and New Zealand.

Several interpretations may be drawn from the microfauna and microflora but in this report only two are considered. The first, or "classical" interpretation is illustrated by figure 7.

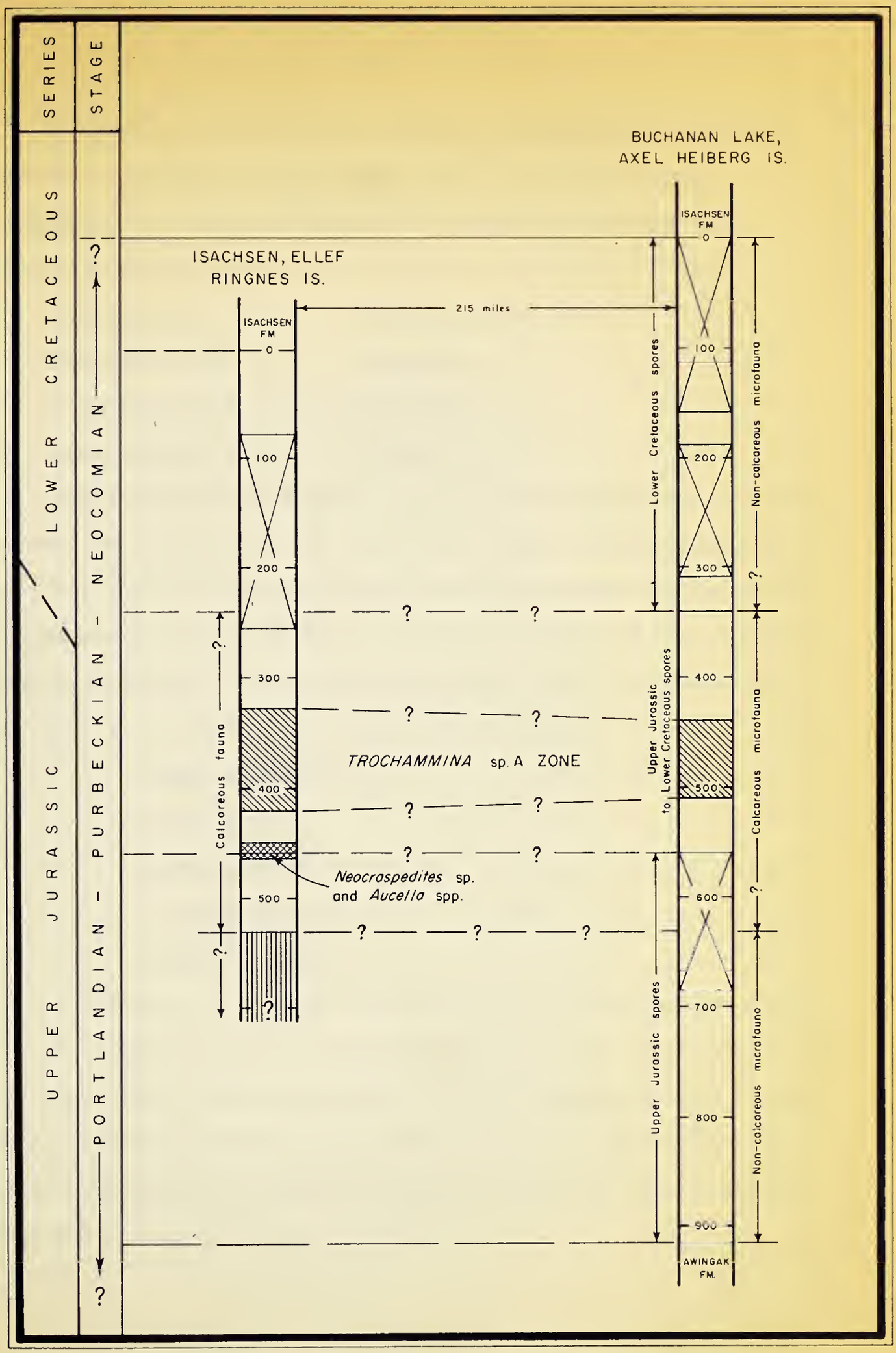


Figure 7. Interpretation Based Upon Correlation of Trochammina sp. A Zone, Deer Bay Formation.

In this case, the interval containing Trochammina sp. A at each locality is assumed to be correlative and is designated as the Trochammina sp. A zone. Restricted to or abundant in this zone at Buchanan Lake are:

Ammobaculites sp. A	Verneuilinoides sp.
Ammobaculites sp. B	Dentalina sp. A
Trochammina sp. A	Dentalina sp. B
Trochammina sp. B	Globulina sp.

Other species also are found in this zone but are neither singularly abundant nor restricted to it. At Buchanan Lake, the Trochammina sp. A zone is 70 feet thick ranging from 450 to 520 feet below the top of the Deer Bay Formation. At Isachsen, the T. sp. A zone is 92 feet thick and spans an interval from 328 to 420 feet below the top of the sequence. Restricted or abundant in this zone at Isachsen are:

Ammobaculites sp. B

Tritaxia sp.

Trochammina sp. A

Trochammina sp. E

Verneuilinoides sp.

In addition, the intervals within which the calcareous fauna occurs at each locality have been correlated and were found to be of approximately equal thickness. This is speculative as covered intervals bound the upper and lower limits of the calcareous fauna. At both localities there is a definite decrease in the number of calcareous forms towards the covered intervals.

After correlating the Trochammina sp. A zone at the two localities, the lowest occurrence of known Lower Cretaceous spores was plotted at 330 feet below the top of the Deer Bay Formation at Buchanan Lake. This position was extended horizontally to intersect the Isachsen section at 240 feet. Similarly, the highest position of known Upper Jurassic spores and dinoflagellates was plotted at Buchanan Lake and extended horizontally to Isachsen where it intersected at 460 feet below the top of the sequence. This point of intersection at Isachsen corresponds with the level where Aucella spp. and ? Neocraspedites sp. were collected and dated as lowermost Lower Cretaceous by Stelck, Warren and the Geological Survey of Canada. The conclusions drawn from this interpretation are:

1. The Jurassic-Cretaceous boundary lies somewhere between 330 and 560 feet below the top of the Deer Bay Formation at Buchanan Lake and between 240 and 460 feet below the top of the formation at Isachsen.
2. The range of the foraminifera in the Deer Bay Formation, as indicated by microspores and the megafauna, is Portlandian or older to about Middle Neocomian. In an interval from 560 to 570 feet below the top of the Buchanan Lake section, Scrinodinium apatelum Cookson and Gonyaula eumorpha Cookson and Eisenack strongly indicate an Oxfordian to Lower Kimmeridgian age for this level. This is the position where the lower limit of the calcareous fauna is found. The calcareous forms above this interval are similar to Jurassic species in Alaska.

3. Marine conditions possibly ended at Isachsen prior to Buchanan Lake. The sea may have withdrawn towards the east or northeast.

If it can be assumed that the rate of sedimentation was greater at Buchanan Lake than at Isachsen, then the sea probably withdrew towards the northwest. This would necessitate a considerable condensation of the section at Isachsen. Tozer (1960) has indicated the possibility of a northwestward migration of the axis of maximum sedimentation within the Sverdrup Basin as time progressed. This, in conjunction with a southeasterly source of sediments as indicated by the Upper Palaeozoic spores and cross bedding at the base of the overlying Isachsen Formation at Buchanan Lake, may suggest a northwesterly regression of the Deer Bay sea.

The second interpretation (Fig. 8), assumes that continental conditions succeeded marine deposition at each locality simultaneously. In this case the Jurassic-Cretaceous boundary lies at the same position in the Buchanan Lake section as it does in Figure 7 but at Isachsen it is lower.

This assumption is questionable because the contact of the Deer Bay Formation with the overlying continental sands of the Isachsen Formation is conformable and gradational at each locality. The writer is showing that any interpretation between those illustrated by Figures 7 and 8 may be possible. Figure 8 shows that the Trochammina sp. A zone and the calcareous fauna interval are not time-correlative in the stratigraphic positions as shown. However, this is not necessarily the case because the Trochammina sp. A zone could still be correlative even though diastrophism affected the whole area at one time.

As may be seen, any number of interpretations might be considered but until more stratigraphic information is available each of the possibilities above will remain hypothetical.

In the following discussion of palaeoecology, the first of these two interpretations only is considered.

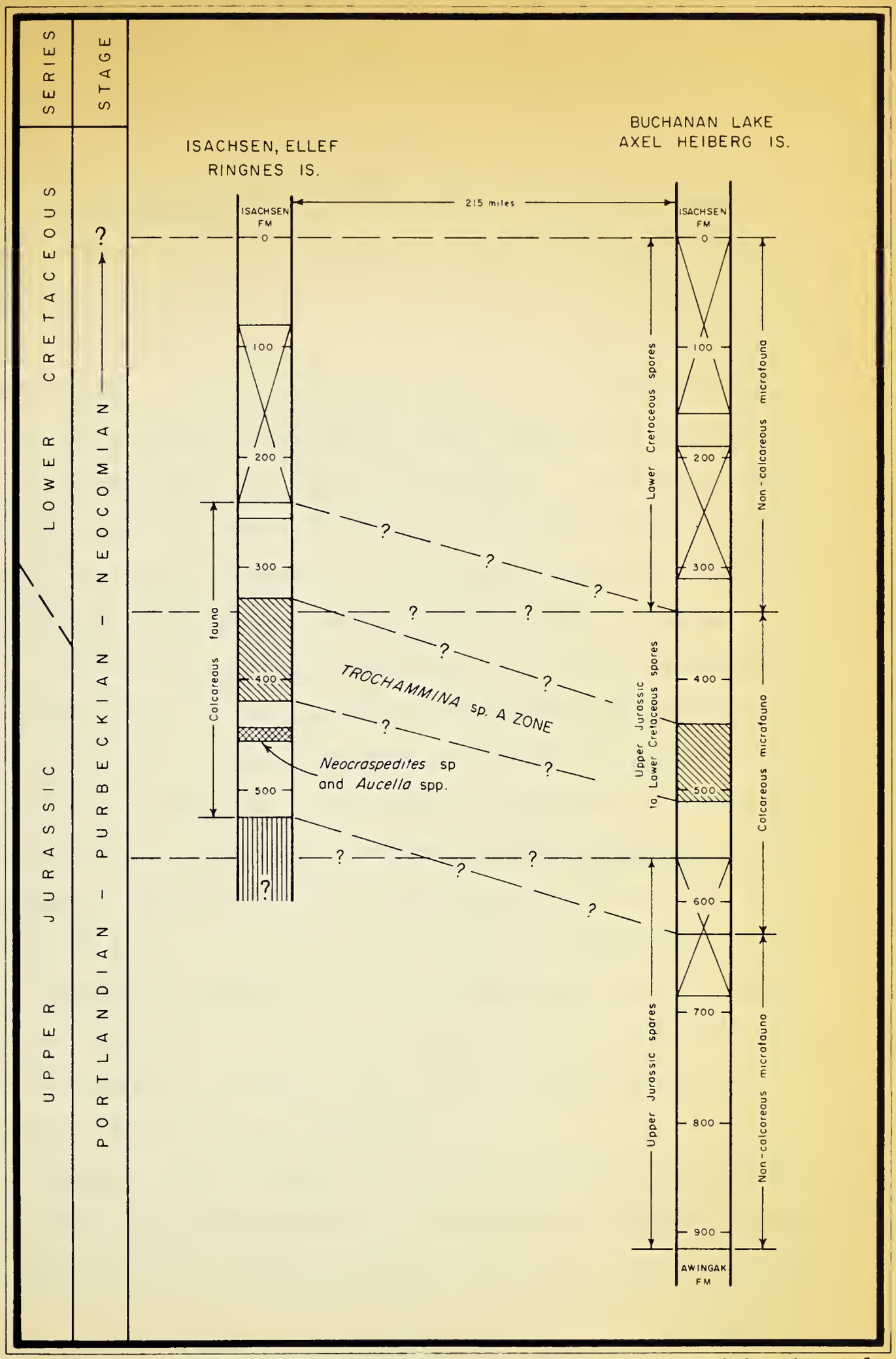


Figure 8. Interpretation Based Upon Simultaneous Return of Continental Conditions to the Sverdrup Basin.

PALAEOECOLOGY

The foraminifera of the Deer Bay Formation probably represent an inner to outer sublittoral environment. Conditions of high turbidity are indicated lithologically by the poorly sorted silt and sand grains within the hard black shale near the base and top of the formation at Buchanan Lake. The continental sand deposits which bound the marine shales of the Deer Bay Formation show cross bedding and mixing of marine and fresh water conditions close to the contacts. The underlying sands of the Awingak Formation at Buchanan Lake are almost entirely unconsolidated. The quartzitic components of this formation are unsorted and slump structures are common, indicating highly turbid conditions.

With the advent of marine deposition, turbid conditions probably continued. Arenaceous foraminifera are very abundant and calcareous forms are entirely lacking throughout the lowermost 230 feet of the formation at Buchanan Lake. The turbid environment was very favourable for the growth of large robust specimens of Haplophragmoides sp. B, Reophax sp., Ammodiscus sp. A and Ammobaculites spp. Many of the arenaceous forms were rapidly buried as several are pyritized.

Towards the northwest, at Isachsen, sublittoral conditions prevailed at this time. The arenaceous foraminifera are not as large as their counterparts at Buchanan Lake and the calcareous species are present in relatively small proportion.

Gradually the sea deepened, more so in the northwest, to allow for the growth of the calcareous forms. Outer sublittoral conditions began at Buchanan Lake and turbidity decreased. The quartz components of the

shale are of silt size and well sorted. The water was probably warm which accounted for the large size of Lenticulina spp. and Dentalina spp. In the northwest the water was slightly deeper allowing forms like Conorboides sp. and Epistomina sp. to thrive in relatively large numbers.

Finally the sea began to shallow, first at Isachsen, then at Buchanan Lake. Turbid conditions reappeared, the large arenaceous forms again became predominant and the calcareous foraminifera disappeared. As the sea withdrew towards the northeast, continental deposition with some intermittent marine periods began at Isachsen. Marine conditions remained at Buchanan Lake for a short time afterwards until increased sedimentation brought this locality above the strand line.

CONCLUSIONS

From this study of the microfauna and microflora of the Deer Bay Formation the following conclusions may be drawn:

1. The foraminifera of the Deer Bay Formation do not appreciably change in biofacies across the Jurassic-Cretaceous boundary in the Arctic Islands.
2. Deposition within the Sverdrup Basin was continuous from the Upper Jurassic to Lower Cretaceous time.
3. On the basis of microspores, dinoflagellates and hystrichosphaerids the Jurassic-Cretaceous boundary lies between 330 and 560 feet below the top of the Deer Bay Formation at Buchanan Lake and between 240 and 460 feet below the top of the sequence at Isachsen, (assuming the interpretation shown by Figure 7 to be correct).
4. The lower levels of the Deer Bay Formation at Buchanan Lake are Portlandian in age or older and the upper levels are Middle Neocomian.
5. Palaeoenvironment changed from inner sublittoral (brackish) and turbid to outer sublittoral and quiet to inner sublittoral and turbid. Water salinity varied from brackish to normal and temperatures were much higher than they are at present in the Arctic Islands.

FORMAL DESCRIPTIONS OF MICROFAUNA

Introductory statement

The Deer Bay Formation of Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island contains 23 arenaceous and 19 calcareous foraminifera with the former being the most abundant at both localities. Comparisons are made with foraminifera described by Tappan (1951, 1955, 1960) from the Jurassic and Cretaceous rocks of northern Alaska, Wall (1960) from the Jurassic rocks of Saskatchewan, and Mellon and Wall (1956) from the Upper McMurray and Basal Clearwater Formations of Alberta. In many cases the Catalogue of Foraminifera (Ellis and Messina) was consulted. A few forms were compared with foraminifera found in the "type" Redwater shale of South Dakota.

The foraminifera are described in order of taxonomic rank with the simple arenaceous types preceding the calcareous forms. The classification used is that proposed by Loeblich and Tappan (1961).

All figured and unfigured specimens have been placed in the foraminiferal type collection at the University of Alberta.

Phylum Protozoa

Subphylum Sarkodina

Class Reticularea

Subclass Granuloreticulosia

Order Foraminiferida

Superfamily Ammodiscacea

Family Ammodiscidae

Subfamily Ammodiscinae

Genus Ammodiscus Terquen, 1862

Ammodiscus sp. A

Plate 2, figures 1-2.

Test large, flat, planispiral, consisting of small proloculum and long undivided tube increasing gradually in diameter, last coil showing much greater increase in diameter than preceding coils; spiral suture depressed, indistinct in early portion, distinct between later volutions; wall very finely arenaceous, of fine sand grains and much cement; aperture formed by open end of tube; colour light brown.

Maximum diameter of figured specimen, 0.95 mm.; minimum diameter, 0.09 mm.; thickness, 0.014 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 370 feet below top of Deer Bay Formation.

Remarks: This species occurs at several levels in the Deer Bay Formation at Buchanan Lake but is most abundant near the base. The species is not common in the Deer Bay Formation at Isachsen, but this scarcity may be due in part to the highly weathered nature of the samples obtained.

Ammodiscus sp. B

Plate 2, figure 9

Test small, flat, planispiral, consisting of small proloculum and long undivided tube making six coils around proloculum and gradually

increasing in diameter during early turns but rapidly widening in penultimate coil; numerous surficial constrictions crossing this undivided chamber, but no true septa present; coiling regular but final coil partly overlapping preceding; spiral suture somewhat indistinct in early coils, distinct in later turns; wall finely arenaceous; aperture indistinct, formed by open end of tube; colour dark grey.

Maximum diameter of figured specimen, 0.45 mm.; minimum diameter, 0.40 mm.; thickness, 0.08 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 400 feet below top of Deer Bay Formation.

Comparison: This species compares favourably with Ammodiscus silicea Terquem from the Kingak shale of Hettangian to Toarcian age in northern Alaska. It differs only in being much smaller and thinner and having less cementing material.

Remarks: This species was found only at Buchanan Lake and was restricted to levels between 370 and 510 feet below the top of the formation.

Genus Ammodiscoides Cushman, 1909

Ammodiscoides sp.

Plate 3, figures 13-14

Test small, conical, consisting of large proloculum and long undivided tube coiling regularly about apical proloculum, each turn gradually increasing in diameter; wall finely arenaceous; aperture formed by open end of tube; colour light brown.

Maximum diameter of figured specimen, 0.39 mm.; diameter of proloculum, 0.07 mm.; height, 0.24 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 735 feet below top of Deer Bay Formation.

Remarks: This species is restricted to the Deer Bay Formation at Buchanan Lake with only one specimen being found.

The specimen illustrated appears to be a juvenile form as the latter coils of adult specimens of the genotype, Ammodiscoides turbinatus Cushman, are planispiral.

Genus Glomospira Rzehak, 1888

Glomospira sp.

Plate 2, figures 15-16

Test small, consisting of proloculum and long undivided tube irregularly overlapping its earlier coils as it winds about the proloculum in an irregular helical manner; suture distinct, depressed; wall finely arenaceous with much cement; aperture formed by open end of tube; colour light brown.

Maximum diameter of figured specimen, 0.35 mm.; minimum diameter, 0.30 mm.; height, 0.28 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; from 370 to 380 feet below top of Deer Bay Formation.

Comparison: This species is similar to Glomospira perplexa Frank described from the Lower Lias of Germany and reported by Tappan (1955) from the Hettangian portion of the Kingak shale of northern Alaska.

Remarks: This species was found only at the Isachsen section where it appears at several levels in the Deer Bay Formation.

Superfamily Lituolacea

Family Ashemonellidae

Subfamily Reophacinae

Genus Reophax Montfort, 1808

Reophax sp.

Plate 1, figure 13

Test very large, consisting of two chambers, the second about twice as large as the first, both spherical in shape; suture distinct, depressed, horizontal; wall arenaceous, of very large angular quartz grains and much cement, surface very rough; aperture terminal, indistinct.

Length of figured specimen, 4.20 mm.; diameter of second chamber, 2.20 mm.; diameter of first chamber, 1.30 mm.; size range of angular quartz grains, 0.25 mm. to 0.40 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 330 feet below top of Deer Bay Formation.

Remarks: This species is abundant at the Buchanan Lake section. The specimen chosen for illustration is likely representative of only one of several species present.

Several forms which are probably referable to this genus were noticed in the Isachsen section, but as preservation at this locality is poor, no specimens were chosen from this section.

Family Lituolidae

Subfamily Haplophragmoidinae

Genus Haplophragmoides Cushman, 1910

Haplophragmoides sp. A

Plate 2, figures 3-5

Test medium to large, robust, slightly compressed, involute on one side, partly evolute on other, appearing moderately trochoid, umbilicus shallow, more pronounced on involute side, periphery broadly rounded; six to eight chambers visible on involute side, seven to nine on evolute side; sutures distinct, depressed, thickened, curved; wall finely arenaceous with some medium-sized grains, much cement; aperture indistinct, an arched opening at base of terminal face; colour brown, pyritized.

Maximum diameter of figured specimen, 0.45 mm.; minimum diameter, 0.40 mm.; maximum thickness of test, 0.40 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 915 feet below top of Deer Bay Formation.

Remarks: This species was found in almost all samples of both sections. In most cases the specimens were badly compressed, distorted and silicified.

Haplophragmoides sp. B

Plate 1, figures 1-4

Test very large, robust, compressed, umbilicus shallow, periphery broadly rounded; chambers distinct, ten to twelve in final whorl, increasing very gradually in size; sutures distinct, slightly depressed, thickened, straight to slightly curved; wall finely arenaceous with much cement, smooth; aperture a high arched opening at base of terminal face; colour light brown to dark grey.

Maximum diameter of figured specimen, 1.20 mm.; minimum diameter, 1.05 mm.; thickness, 0.75 mm.; maximum diameter of largest specimen, 2.50 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 340 feet below top of Deer Bay Formation.

Comparison: This species is similar to Haplophragmoides canui Cushman reported by Tappan (1955) from the Oxfordian portion of the Kingak shale of northern Alaska. It differs from H. canui in being much larger in all dimensions.

Remarks: This species is highly variable in general appearance because of distortion in fossilization. The specimen illustrated as figures 3-4 of plate 1 shows the most common condition of preservation.

Haplophragmoides sp. C

Plate 2, figures 20-21

Test medium-sized, very robust, involute, umbilicus shallow, periphery broadly rounded; chambers distinct, five to six in number, increasing very gradually in size; sutures distinct, flush, thickened, somewhat sinuous in later portion of coil; ultimate chamber with prominent raised thick lip extending completely around periphery of terminal face as far as umbilicus on both sides of test; wall finely arenaceous with much cement; aperture indistinct, an arched opening at base of terminal face; colour light brown.

Maximum diameter of figured specimen, 0.48 mm.; maximum thickness, 0.38 mm.; unfigured specimens range from 0.20 mm. to 0.50 mm. in diameter.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; from 328 to 338 feet below top of Deer Bay Formation.

Remarks: This species is restricted to a depth of 328 to 380 feet below the top of the Deer Bay Formation at Isachsen.

Subfamily Lituolinae

Genus Ammobaculites Cushman, 1910

Ammobaculites sp. A

Plate 2, figures 11-14

Test small to medium, early portion comprising about one-third length, compressed, somewhat trochoid, moderately umbilicate; later

portion straight to slightly curved, uniserial, cylindrical; in coiled portion five to six chambers visible on evolute side, four on involute side, proloculum distinct on evolute side; three to five chambers of equal size in uniserial portion, somewhat inflated; sutures in coiled portion distinct, depressed, slightly curved, in uniserial portion horizontal on one side, oblique on other side; wall finely to coarsely arencaceous, much cement, generally smooth; aperture distinct, terminal, round; colour light to dark brown, some specimens pyritized.

Length of figured specimen, 0.60 mm.; diameter of coil, 0.22mm.; length of ultimate chamber, 0.17 mm.; diameter of uniserial portion, 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 520 feet below top of Deer Bay Formation.

Comparison: This species compares favourably with Ammobaculites cobbani Loeblich and Tappan reported by Wall (1960) from the Vanguard Formation (Callovian to Oxfordian) of Saskatchewan. It also resmebles the paratypes of A. alaskensis Tappan from the Upper Jurassic rocks of northern Alaska illustrated as figures 1a and 1b of plate 12 in the original publication (Tappan, 1955), but differs in being smaller in all dimensions.

Remarks: This species is found throughout both the Buchanan Lake and Isachsen sections.

Ammobaculites sp. B

Plate 1, figure 10

Test medium-sized, coiled portion comprising about one-third length, compressed, flattened, involute; latter portion straight, uniserial, flattened; four chambers exposed in coiled portion, gradually increasing in size, three to five chambers in uniserial portion, the early ones small and of equal size, the ultimate chamber inflated; sutures in coiled portion indistinct, flush, straight, radial, in uniserial portion distinct, slightly depressed, slightly oblique; wall coarsely arenaceous, smooth; aperture indistinct, terminal; colour light brown.

Length of figured specimen, 0.90 mm.; diameter of coil, 0.35 mm.; length of ultimate chamber, 0.25 mm.; width of test, 0.22 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 695 feet below top of Deer Bay Formation.

Comparison: This species also compares favourably with Ammobaculites cobbani Loeblich and Tappan reported by Wall (1960) from the Vanguard Formation (Oxfordian portion) of Saskatchewan. It is the writer's opinion that A. sp. A and A sp. B are two distinct species.

Remarks: This species occurs in the Deer Bay Formation at both localities.

Ammobaculites sp. C

Plate 2, figures 17-19

Test medium-sized, coiled portion comprising about one-third length, indistinct, involute; latter portion uniserial, straight, cylindrical; coil planispiral consisting of several very small gradually enlarging chambers, ultimate chamber of coil greatly enlarged, inflated, about twice as wide as ultimate chamber of uniserial portion; three chambers in uniserial part decreasing in size and becoming spherical towards apertural end; sutures of coil indistinct, depressed, in uniserial portion distinct, depressed, horizontal; wall finely arenaceous; aperture distinct, terminal, round; colour dark brown.

Length of figured specimen, 0.67 mm.; diameter of coil, 0.25 mm.; width of ultimate chamber of coil, 0.38 mm.; diameter of penultimate chamber, 0.28 mm.; diameter of ultimate chamber 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 825 feet below top of Dee Bay Formation.

Remarks: Two specimens only were found in the Buchanan Lake section.

Ammobaculites sp. D

Plate 1, figures 11-12

Test large, coiled portion comprising about one-third length, planispiral, involute, moderately umbilicate, latter portion straight, slightly curved in early part, uniserial, cylindrical; coil consisting

of five gradually enlarging chambers, uniserial part with four to six gradually enlarging chambers, ultimate chamber inflated; sutures of coil indistinct, depressed, curved, sutures of uniserial part distinct, depressed, horizontal; wall coarsely arenaceous, much cement; aperture indistinct, terminal.

Length of specimen (Plate 1, figure 12), 1.51 mm.; diameter of coil, 0.50 mm.; width of ultimate chamber, 0.70 mm.; width of central uniserial portion, 0.50 mm.

Length of specimen (Plate 1, figure 11), 2.42 mm.; width of ultimate chamber, 1.00 mm.; width of central uniserial portion, 0.85 mm.

Locality and level of figured specimens: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; the specimens illustrated as figure 11 and figure 12 are from 705 and 715 feet, respectively, below the top of the Deer Bay Formation.

Comparison: The specimen (figure 12) of this species is similar to Ammobaculites wenonahae Tappan from the Grandstand Formation (Middle Albian) of Alaska. The specimen (figure 11) is similar to A. imlayi Loeblich and Tappan from the Oxfordian portion of the Redwater shale of South Dakota. It is possible that two species are referred to Ammobaculites sp. D.

Preservation of these specimens is very poor and the above description is based on both figured specimens. Definite visible characteristics are few, thus preventing a more precise speciation.

Remarks: This species was found only in the lower portion of the Buchanan Lake section.

Ammobaculites sp. E

Plate 2, figure 10

Test large, coiled portion comprising about one-eighth length, compressed, planispiral, involute, moderately umbilicate, later portion straight, uniserial, flattened; coil consisting of four chambers of equal size, uniserial portion consisting of five or more distinct chambers, gradually increasing in height and width; sutures of coil distinct, depressed, slightly curved, sutures of uniserial portion distinct, depressed, horizontal; wall finely arenaceous, moderate amount of cement; aperture indistinct, terminal; colour brown.

Length of figured specimen, 1.65 mm.; diameter of coil, 0.20 mm.; width of penultimate chamber, 0.40 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 430 feet below top of Deer Bay Formation.

Comparison: This species is similar to Ammobaculites alaskensis Tappan. It is the writer's opinion that those forms described under this species (Tappan, 1955) should be regrouped under separate species. A. sp. E compares favourably with part of A. alaskensis as shown by figures 7a and 7b of plate 12 in the original publication.

Remarks: Two specimens were found in the Deer Bay Formation at Buchanan Lake.

Family Trochamminidae

Genus Trochammina Parker and Jones, 1859

Trochammina sp. A

Plate 3, figures 7-9

Test small, globular, trochoid, periphery broadly rounded; chambers of dorsal side indistinct, numerous, only five to six visible ventrally, reaching to umbilicus; chambers globular, inflated, increasing rapidly in size as added; sutures distinct, depressed; wall finely arenacoues; aperture indistinct, at base of ultimate chamber, ventral; colour brown, pyritized.

Maximum diameter of figured specimen, 0.25 mm.; minimum diameter, 0.20 mm.; thickness, 0.16 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 470 feet below top of Deer Bay Formation.

Comparison: The species is similar to Trochammina canningensis Tappan reported from the Kingak shale (Pleinsbachian to Oxfordian) of northern Alaska.

Remarks: At Buchanan Lake this species occurs regularly throughout an interval of 450 to 520 feet below the top of the Deer Bay Formation. At Isachsen the species is common throughout the lower half of the formation but it is most abundant in an interval of 328 to 420 feet below the top.

Trochammina sp. B

Plate 3, figures 1-3

Test medium-sized, subglobular, trochoid with low spire, periphery broadly rounded; early whorls indistinct, seven chambers visible in penultimate whorl, eight in ultimate, chambers gradually increasing in size as added, slightly inflated dorsally; sutures distinct, depressed, curved; wall finely arenaceous; aperture a thin slit projecting ventrally from periphery at base of ultimate chamber; colour brown, pyritized.

Maximum diameter of figured specimen, 0.51 mm.; minimum diameter, 0.36 mm.; thickness, 0.28 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 490 feet below top of Deer Bay Formation.

Remarks: The species occurs sporadically throughout both sections. At Buchanan Lake it is most abundant in the same interval as T. sp. A, and at Isachsen it occurs from 370 to 400 feet below the top of the Deer Bay Formation.

Trochammina sp. C

Plate 3, figures 4-6

Test medium-sized, globular, trochoid, forming low spire, periphery broadly rounded, lobate, test flat ventrally; early chambers indistinct, seven in penultimate whorl, six to seven in final turn, chambers gradually increasing in size as added, globular, all chambers visible dorsally, only those of last coil exposed ventrally; sutures distinct, depressed,

curved; wall finely to coarsely arenaceous, much cement, smooth; aperture indistinct, an arched opening at base of ultimate chamber, ventral; colour dark brown.

Maximum diameter of figured specimen, 0.80 mm.; minimum diameter, 0.50 mm.; thickness, 0.34 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 330 feet below top of Deer Bay Formation.

Comparison: This species is similar to Trochammina sablei reported from several levels of the Kingak shale (Hettangian to Oxfordian) of northern Alaska. The species differs from T. sablei in being about twice as large in all directions.

Remarks: Two specimens only were found in the Buchanan Lake section. Several specimens which may have been referable to this species were noticed, but preservation was very poor, thus preventing positive comparison.

Trochammina sp. D

Plate 1, figures 5-6

Test large, globular, trochoid with very low spire, ventral side flat, periphery lobate, broadly rounded; earliest chambers indistinct, three in penultimate whorl, five large globular chambers in ultimate whorl, chambers rapidly increasing in size, all chambers visible dorsally, only those of last coil exposed ventrally; sutures distinct, depressed, curved; wall finely arenaceous, aperture indistinct, extending ventrally from periphery at base of ultimate chamber; colour light brown.

Maximum diameter of figured specimen, 0.60 mm.; minimum diameter, 0.50 mm.; thickness, 0.28 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 288 to 298 feet below top of Deer Bay Formation.

Comparison: This species compares favourably with Trochammina umiatensis Tappan from the Cretaceous Grandstand Formation of northern Alaska.

Remarks: This species was found in the interval from 288 to 338 feet below the top of the Deer Bay Formation at Isachsen, Ellef Ringnes Island.

Trochammina sp. E

Plate 3, figures 10-12

Test small, plano-convex, trochoid with flat spire, ventral side strongly convex, dorsal side flat with umbilical area slightly depressed, periphery rounded; ten chambers in early coil, eight in penultimate, six globular chambers in ultimate whorl; all chambers exposed dorsally, only those of last whorl exposed ventrally; sutures distinct, depressed, straight ventrally, curved on dorsal side; wall finely arenaceous; aperture indistinct, a thin slit extending ventrally from periphery at base of ultimate chamber; colour brownish yellow.

Diameter of figured specimen, 0.25 mm.; thickness, 0.17 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 328 to 338 feet below top of Deer Bay Formation.

Remarks: This species occurs in two isolated intervals of the Isachsen section: 328 to 400 and 474 to 524 feet below the top of the Deer Bay Formation.

Trochammina sp. F

Plate 1, figures 7-9

Test small, plano-convex, trochoid with high dorsal spire, periphery subacute; chambers indistinct in early coils, six in penultimate, three in ultimate coil, chambers gradually increasing in size as added, only those of ultimate whorl visible ventrally, chambers slightly inflated ventrally; sutures distinct, slightly depressed, curved, oblique in counterclockwise direction; wall finely arenaceous; aperture indistinct, ventral; colour orange.

Diameter of figured specimen, 0.46 mm.; thickness, 0.23 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 355 to 357 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Family Ataxophragmiidae

Subfamily Verneuilininae

Genus Verneuilinoides Loeblich and Tappan, 1949

Verneuilinoides sp.

Plate 3, figures 18-19

Test minute, tapering, triangular in cross section with angles rounded; test triserial with six convolutions of three chambers each; chambers globular, increasing gradually in size, chambers of ultimate whorl greatly inflated; sutures distinct, depressed; wall finely arenaceous with much cement, smooth; aperture a notch at base of ultimate chamber; colour dark brown.

Length of figured specimen, 0.30 mm.; greatest width, 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 490 feet below top of Deer Bay Formation.

Comparison: This species is similar to Verneuilinoides tryphera Loeblich and Tappan reported by Wall (1960) from the upper part of the Vanguard Formation (Oxfordian to Kimmeridgian) of Saskatchewan.

The species compares very favorably with the holotype from the type Redwater shale (Oxfordian) of South Dakota (Loeblich and Tappan, 1950). The species differs from the holotype in being twice as large in all dimensions.

Remarks: This species occurs in both the Buchanan Lake and Isachsen sections. At the former locality it is most abundant within an interval of 480 to 490 feet below the top of the Deer Bay Formation. At Isachsen it is relatively abundant in an interval from 328 to 400 feet below the top of the formation.

The species was always found in the -120 mesh fraction.

Genus Verneuilina d'Orbigny, 1840

Verneuilina sp.

Plate 3, figures 20-21

Test very small, tapering, semitriangular in cross section with angles broadly rounded; test triserial with five convolutions of three chambers each; chambers globular, gradually increasing in size; sutures distinct, depressed; wall finely arenaceous, moderate cement; aperture distinct, an arched opening at base of ultimate chamber; colour brown, pyritized.

Length of figured specimen, 0.30 mm.; maximum width, 0.14 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 474 to 484 feet below top of Deer Bay Formation.

Remarks: This species is rare in the lowermost 40 feet of the Deer Bay Formation at Isachsen.

Genus Tritaxia Reuss, 1860

Tritaxia sp.

Plate 2, figure 8

Test medium-sized, elongate, triserial, tapering, usually badly flattened in fossilization; chambers indistinct, rapidly expanding, inflated, twelve or more in number; sutures indistinct, depressed; wall finely to coarsely arenaceous, much cement, smooth; aperture indistinct, terminal, some specimens with remnant of short neck; colour grey.

Length of figured specimen, 0.50 mm.; maximum width, 0.30 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 451 to 464 feet below top of Deer Bay Formation.

Comparison: Unfigured specimens of this species bear some similarity to Tritaxia manitobensis Wickenden from the Tuktu and Topagoruk Formations of northern Alaska (Tappan, 1951). It also compares favourably with Tritaxia athabascensis Mellon and Wall described from the basal Clearwater Formation of Alberta (Mellon and Wall, 1956).

Remarks: This species occurs regularly from 328 to 420 feet below the top of the Deer Bay Formation at Isachsen, Ellef Ringnes Island.

Family Textulariidae

Subfamily Textulariinae

Genus Textularia Defrance, 1824

Textularia sp.

Plate 2, figures 6-7

Test elongate, tapering, moderately compressed, biserial, periphery broadly rounded; chambers in earliest portion indistinct, distinct in later portion, seven in number, inflated, rapidly increasing in size towards apertural end; sutures distinct, slightly depressed; wall finely arenaceous, moderate cement, smooth; aperture distinct, a low arched opening at base of terminal face; pyritized.

Length of figured specimen, 0.48 mm.; maximum width, 0.25 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 355 to 357 feet below top of Deer Bay Formation.

Remarks: This species occurs very rarely in the upper and middle levels of the Deer Bay Formation at Isachsen.

Superfamily Nodosariacea

Family Nodosariidae

Subfamily Nodosariinae

Genus Lenticulina Lamark, 1804

Lenticulina sp. A

Plate 4, figures 10-11

Test large, lenticular, planispiral, involute, moderately bi-umbonate with umbos clear, periphery subacute with indistinct narrow keel; chambers distinct, seven to eight in final whorl, gradually enlarging as added; sutures distinct, thickened, flush, curved, more so at peripheral margin and between earlier chambers of ultimate whorl; wall calcareous, hyaline, finely perforate; aperture terminal, at peripheral angle, radiate.

Maximum diameter of figured specimen, 0.46 mm.; minimum diameter, 0.35 mm.; maximum thickness, 0.21 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 feet below top of Deer Bay Formation.

Remarks: This species is found only in the Buchanan Lake section. It is most abundant in the interval from 480 to 560 feet below the top of the Deer Bay Formation.

Lenticulina sp. B

Plate 5, figures 6-7

Test medium-sized, lenticular, planispiral, moderately involute, biumbonate with umbos clear, terminal face distinctly small and triangular, periphery subacute with narrow keel tending to be straight between sutures; chambers distinct, eight in final whorl, gradually enlarging as added; sutures distinct, flush, thickened, straight, short; wall calcareous, hyaline; aperture indistinct, at peripheral angle; colour light and dark brown.

Maximum diameter of figured specimen, 0.62 mm.; minimum diameter, 0.53 mm.; thickness, 0.30 mm.

Locality and level of figured specimen; Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 feet below top of Deer Bay Formation.

Remarks: This species occurs very rarely throughout the lower half of the Deer Bay Formation at Buchanan Lake.

Lenticulina sp. C

Plate 5, figures 8-9

Test large, lenticular, planispiral, involute, biumbonate with umbos indistinct, terminal face high and narrow, periphery narrowly rounded with very thin keel; chambers distinct, seven to eight in final whorl, gradually enlarging as added; sutures distinct, slightly raised, curved, moderately thickened; wall calcareous; aperture indistinct, at peripheral angle; colour yellow.

Maximum diameter of figured specimen, 0.98 mm.; minimum diameter, 0.65 mm.; thickness, 0.36 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 410 feet below top of Deer Bay Formation.

Remarks: This species is found in both sections of the Deer Bay Formation. At Buchanan Lake it occurs in an interval from 410 to 540 feet below the top of the formation, and at Isachsen it is found between 390 and 484 feet below the top of the section.

Lenticulina sp. D

Plate 4, figures 12-13

Test small, lenticular, planispiral, involute, biumbonate with clear, distinct umbos, periphery subacute with thin, distinct keel, terminal face narrow and high; chambers distinct, nine to ten in ultimate whorl, gradually increasing in size as added; sutures distinctly raised, curved, somewhat thickened; wall calcareous, hyaline; aperture distinct, a round opening at peripheral angle, radiate, may have a slight neck; colour yellowish brown.

Maximum diameter of figured specimen, 0.38 mm.; minimum diameter, 0.26 mm.; thickness, 0.14 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 450 feet below top of Deer Bay Formation.

Remarks: Two specimens only were found at the 450 foot level of the Deer Bay Formation at Isachsen.

Genus Saracenaria Defrance, 1824

Saracenaria sp. A

Plate 4, figures 4-5

Test small to medium-sized, compressed, curved dorsally, straight ventrally, uncoiling with penultimate chamber reaching back almost to coiled portion, periphery narrowly rounded; chambers in coiled portion indistinct, three to four in number, two chambers in uncoiled part; chambers rapidly increasing in size, those in uncoiled portion inflated, triangular in cross section; sutures indistinct in coiled portion, distinct and depressed in latter part, strongly curved in coiled portion, oblique in uncoiled portion; wall calcareous, perforate; aperture radiate, at peripheral angle with short neck; colour white.

Length of figured specimen, 0.44 mm.; width of ultimate chamber, 0.20 mm.; diameter of coiled portion, 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 540 feet below top of Deer Bay Formation.

Remarks: Two specimens of this species were found 540 feet below the top of the Deer Bay Formation at Buchanan Lake.

Saracenaria sp. B

Plate 4, figures 1-3

Test medium-sized, compressed, convex dorsally, straight to slightly concave ventrally, uncoiling, terminal face wide, comprising about one-half length of test, periphery acute; chambers distinct, three in coiled

portion, four in uncoiled portion, gradually increasing in size, ultimate chamber inflated, triangular in cross section; sutures distinct, depressed, curved in early portion, oblique in uncoiled portion; wall calcareous, perforate; aperture indistinct, at peripheral angle; colour yellow, partly silicified, partly pyritized.

Length of figured specimen, 0.50 mm.; width of ultimate chamber, 0.28 mm.; diameter of coil, 0.08 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 510 feet below top of Deer Bay Formation.

Remarks: Two specimens of this species were found 510 feet below the top of the Deer Bay Formation at Buchanan Lake.

<u>Saracenaria</u> sp. C

Plate 4, figures 6-7

Test small, compressed, close coiled, involute, strongly convex dorsally, latter portion flaring, triangular in cross section, wide, comprising about two-thirds length, periphery acute; chambers indistinct, six or more in number, gradually enlarging but not actually uncoiling; sutures distinct, raised, moderately thickened, curved; wall calcareous, perforate; aperture indistinct, at peripheral angle; colour white, silicified.

Length of figured specimen, 0.38 mm.; width of ultimate chamber, 0.22 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 530 feet below top of Deer Bay Formation.

Remarks: Two specimens of this species were found at 480 and 530 feet below the top of the Deer Bay Formation at Buchanan Lake.

Saracenaria sp. D

Plate 4, figures 8-9

Test small, compressed, moderately close coiled, ultimate chamber reaching back almost to coiled portion, convex dorsally, concave ventrally, periphery narrowly rounded but not acute, terminal face comprising about two-thirds length of test, narrow; chambers indistinct, five or more in number, gradually increasing in size in early portion, rapidly expanding and inflated in latter part; sutures indistinct, depressed, curved; aperture indistinct, at peripheral angle; colour white, partly silicified, partly pyritized.

Length of figured specimen, 0.42 mm.; width of ultimate chamber, 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 490 feet below top of Deer Bay Formation.

Remarks: This species occurs rarely between 460 and 530 feet below the top of the Deer Bay Formation at Buchanan Lake.

Saracenaria spp.

Unfigured

A few specimens of Saracenaria spp. were found in the Deer Bay Formation at Isachsen, Ellef Ringnes Island. However, as preservation

was very poor the writer was unable to compare these specimens with any of those in the Buchanan Lake section.

In addition, in both sections fragments of what appeared to be Saracenaria were found. These fragments may have been the ultimate chambers of specimens of this genus. They were found at several levels in the formation at each locality.

Genus Astacolus Montfort, 1808

Astacolus sp.

Plate 4, figures 14-15

Test small, elongate, narrow, early portion close coiled, later portion uncoiling with chambers extending back towards coil, dorsal and ventral margins of uncoiled portion parallel, periphery subacute; chambers of coil indistinct, four in uncoiled portion, gradually increasing in size as added; sutures indistinct, depressed, oblique, curved in early portion becoming straight in latter part; wall calcareous; aperture distinct, at peripheral angle with short neck, radiate; colour orange.

Length of figured specimen, 0.40 mm.; maximum thickness, 0.13 mm.; maximum width, 0.20 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 feet below top of Deer Bay Formation.

Comparison: This species is similar to Saracenaria grandstandensis Tappan reported by Tappan (1960) from the Grandstand Formation (Cretaceous) of northern Alaska. It differs from S. grandstandensis in being smaller

in all dimensions. In the original report Tappan claims that S. grandstandensis is identical to S. sp. C Stelck and Wall reported from the Clearwater Formation (Middle Albian) of Alberta. The writer feels that there is very little similarity between these two species nor is any similarity apparent between S. sp. C and Astacolus sp.

Remarks: This species was assigned to the genus Astacolus because it is not triangular in cross section as are the representatives of the genus Saracenaria. The species was present only between 560 and 570 feet below the top of the Deer Bay Formation at Buchanan Lake.

Genus Vaginulina d'Orbigny, 1826

Vaginulina sp.

Plate 4, figures 16-18

Test medium-sized, strongly compressed, flat, thin, tear-shaped, periphery narrowly rounded; early portion close coiled, chambers indistinct, four or more in number, later portion uncoiling, four or five elongate chambers extending back to coil, chambers very gradually increasing in size as added; sutures distinct, slightly raised, curved in coil, oblique, gently recurved near dorsal margin; umbos distinct, raised; wall calcareous, hyaline; aperture indistinct, at peripheral angle, radiate; colour white.

Length of specimen (Plate 4, figures 16-17), 0.40 mm.; maximum width, 0.23 mm.; thickness, 0.08 mm.

Length of specimen (Plate 4, figure 18), 0.55 mm.; maximum width, 0.26 mm.; thickness, 0.09 mm.

Locality and level of figured specimens: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; the specimens illustrated as figures 16-17, and figure 18 are from 430 and 560 feet, respectively, below the top of the Deer Bay Formation.

Remarks: The two figured specimens represent the only occurrence of this species in the Deer Bay Formation at Buchanan Lake.

Genus Vaginulinopsis Silvestri, 1904

Vaginulinopsis sp.

Plate 3, figures 25-26

Test medium-sized, moderately compressed, narrow, elongate, early portion close coiled, involute, later stage uniserial, straight, sides parallel, periphery narrowly rounded in early stage, broadly rounded in uniserial portion, ovoid in cross section; chambers of coiled portion indistinct, four or five in uniserial part extending back towards coiled portion; sutures of uniserial portion distinct, depressed, moderately oblique; wall calcareous, hyaline; aperture radiate, at outer peripheral angle, slightly produced; colour white.

Length of figured specimen, 0.50 mm.; maximum width, 0.22 mm.; maximum thickness, 0.18 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 510 feet below top of Deer Bay Formation.

Comparison: This species resembles Vaginulinopsis mututina (d'Orbigny) reported by Tappan (1955) from the Lower Jurassic rocks of northern

Alaska. The species may also be compared with many other Alaskan species such as Marginulina psila Tappan of Lower Jurassic age. Because the establishment of species of Marginulina, Marginulinopsis and Vaginulinopsis is largely subjective, any comparison of the figured specimen with published species is merely a reflection of the author's personal appraisal of variability.

Remarks: Two specimens of this species were found 510 feet below the top of the Deer Bay Formation at Buchanan Lake.

Genus Marginulinopsis Silvestri, 1904

Marginulinopsis sp.

Plate 3, figures 22-23

Test small, robust, early portion close coiled, involute, later portion uniserial, circular in cross section, coiled stage somewhat triangular in cross section with ventral periphery narrowly rounded, dorsal periphery broadly rounded; chambers in coiled stage numerous, indistinct, three in uniserial portion, rapidly increasing in size, becoming spherical towards apertural end; sutures depressed, obscured by longitudinal costae; wall calcareous, perforate; aperture terminal, radiate, slightly produced; colour light brown.

Length of figured specimen, 0.38 mm.; maximum diameter of coil, 0.21 mm.; maximum diameter of uniserial portion, 0.25 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 feet below top of Deer Bay Formation.

Comparison: This species is similar to Marginulina prima d'Orbigny reported by Tappan (1955) from the Jurassic rocks of northern Alaska. M. sp. compares favourably with that part of M. prima illustrated by figures 6, 7, and 8 of plate 20 in Tappan's report.

Remarks: This species was found at both localities. At Buchanan Lake it occurs commonly between 430 and 560 feet below the top of the Deer Bay Formation. At Isachsen it occurs rarely between 451 and 484 feet below the top of the formation.

Genus Dentalina d'Orbigny, 1826

Dentalina sp. A

Plate 3, figure 17

Test large, elongate, slender, circular in cross section, slightly curved, base rounded; chambers distinct, more than five in number, irregular in size, globular, semispherical; sutures distinct, depressed, transverse; wall calcareous, hyaline; aperture terminal; colour white.

Length of figured specimen, 1.20 mm.; maximum diameter, 0.33 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 510 feet below top of Deer Bay Formation.

Remarks: Two specimens of this species were found 510 feet below the top of the Deer Bay Formation at Buchanan Lake. These specimens were both broken, and several other forms which may be referable to this species were noticed but were very poorly preserved.

Dentalina sp. B

Plate 3, figure 16

Test large, slender, elongate, arcuate, oval in cross section; chambers increasing gradually in size from broken base, more than six in number, ultimate chamber about twice as long as penultimate and drawn out into a blunt point; chambers inflated centrally, constricted at sutures; sutures distinct, depressed, oblique; wall calcareous, perforate; aperture radiate, terminal, produced; colour dark grey.

Length of figured specimen, 1.75 mm.; maximum width, 0.30 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 490 feet below top of Deer Bay Formation.

Comparison: This species compares favourably with Dentalina ectadia Loeblich and Tappan reported by Wall (1960) from the Lower Vanguard Formation (Callovian) of Saskatchewan. It differs from D. ectadia in being much larger.

Remarks: The species occurs fairly commonly between 450 and 560 feet below the top of the Deer Bay Formation at Buchanan Lake.

Genus Nodosaria Lamarck, 1812

Nodosaria sp. A

Plate 5, figures 4-5

Test large, elongate, rectilinear, uniserial, strongly constricted at sutures; chambers globular, two in number, ultimate chamber about twice as large as first; suture distinct, transverse to slightly oblique, very

strongly depressed; wall calcareous, perforate; aperture distinct, terminal, radiate; colour white, silicified.

Length of figured specimen, 0.87 mm.; diameter of ultimate chamber, 0.38 mm.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 480 feet below top of Deer Bay Formation.

Remarks: Several specimens which may be referable to this species were found between 460 and 480 feet below the top of the Deer Bay Formation at Buchanan Lake.

Nodosaria sp. B

Plate 3, figure 15

Test medium-sized, elongate, tapering, uniserial; chambers subglobular to globular, four in number, gradually increasing in size, ultimate chamber inflated, about twice as large as penultimate chamber; sutures distinct, transverse, depressed; wall calcareous, perforate; aperture distinct, terminal, radiate, with prominent neck; colour orange.

Length of figured specimen, 0.57 mm.; diameter of ultimate chamber, 0.20 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 430 to 440 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Family Polymorphinidae

Subfamily Polymorphininae

Genus Globulina d'Orbigny, 1839

Globulina sp.

Plate 3, figure 24

Test small, ovate; chambers globuline in arrangement, three in number, the last two overlapping the first so that only a small portion is visible, final chamber comprising about two-thirds length; sutures distinct, oblique, slightly depressed; wall calcareous, perforate; aperture terminal, radiate, slightly produced; colour orange.

Length of figured specimen, 0.38 mm.; maximum diameter, 0.25 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 355 to 357 feet below top of Deer Bay Formation.

Comparison: This species resembles Globulina topagorukensis Tappan from the Upper Jurassic rocks of northern Alaska. It differs from G. topagorukensis in having slightly less overlap of the chambers.

Remarks: This species is abundant in the Deer Bay Formation at Isachsen and Buchanan Lake. At the former locality it occurs throughout the exposed section, and at Buchanan Lake it does not occur below 560 feet from the top of the formation.

Superfamily Rotaliacea

Family Rotaliidae

Genus Epistomina Terquem, 1883

Epistomina sp.

Plate 5, figures 10-11

Test large, trochoid, biconvex, of three whorls, ventral side strongly convex, dorsal side with low conical spire, periphery subacute; chambers indistinct, seven or more in ultimate whorl, gradually enlarging as added, only those of ultimate whorl visible ventrally; sutures indistinct, moderately thickened, flush, curved; wall calcareous, hyaline; primary aperture at inner margin on ventral side of last chamber, auxiliary apertures distinct, elongate openings along peripheral margin, large; colour white.

Maximum diameter of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 451 to 464 feet below top of Deer Bay Formation.

Remarks: This species is abundant in an interval from 451 to 484 feet below the top of the Deer Bay Formation at Isachsen.

Superfamily Asterigerinacea

Family Discorbidae

Genus Conorboides Hofker, 1952

Conorboides sp.

Plate 5, figures 1-3

Test small, trochoid, equally biconvex, periphery slightly to moderately lobate, subacute; chambers distinct, four in early coil,

five in penultimate, six in ultimate whorl, chambers gradually increasing in size as added, all visible dorsally, only those of ultimate whorl exposed ventrally; sutures distinct, thick, raised, arcuate; wall calcareous, hyaline, finely perforate; apertures indistinct, ventral, multiple, consisting of loop-shaped openings running axially from base of sutures onto chamber faces; colour white, silicified.

Maximum diameter of figured specimen, 0.54 mm.; minimum diameter, 0.45 mm.; thickness, 0.26 mm.

Locality and level of figured specimen: Isachsen, Ellef Ringnes Island, Northwest Territories, Canada; 451 to 464 feet below top of Deer Bay Formation.

Comparison: This species compares favourably with Conorboides hofkeri (Bartenstein and Brand) reported by Wall (1960) from the Vanguard Formation (Callovian to Kimmeridgian) of Saskatchewan.

Remarks: This species is abundant in an interval from 410 to 451 feet below the top of the Deer Bay Formation at Isachsen. The type locality of this species is in Valanginian beds of northwestern Germany.

DESCRIPTIONS OF MICROFLORA

Introductory statement

Fourteen Mesozoic microspores, six Palaeozoic microspores, two dinoflafellates and two hystrichosphaerids are briefly described and illustrated from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island, Northwest Territories.

Descriptions are very brief and no taxonomic characteristics are discussed. Species are described according to age and occurrence within the formation. Comparison was made with species described by Couper (1958) from the Wealden and Neocomian of England; Pocock (unpublished) from the Lower Mannville of Alberta; Hughes and Playford (1961) from the Lower Carboniferous of Spitsbergen; Balme (1957) from the Mesozoic of western Australia; and Cookson and Eisenack (1960) from the Upper Mesozoic of Australia and New Guinea. Reference was frequently made to the Catalogue of Fossil Spores and Pollen (Kremp and Spackman).

All figured and unfigured species were placed in the micropaleontological type collection at the University of Alberta.

Mesozoic Microspores, Hystrichosphaerids and Dinoflagellates

Ricciisporites convolutus Pocock, 1960

Plate 6, figure 1

Diameter: 88 microns

Geologic range: Neocomian (Ellerslie Formation, Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This species occurs between 170 and 410 feet below the top of the Deer Bay Formation at Buchanan Lake. This form is a tetrad made up of four microspores.

Appendicisporites tricornitatus Weyland and Greifelf, 1953

Plate 6, figure 2

Diameter: 76 microns

Geologic range: Wealden to Aptian (England), Lower Senonian (Germany).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This species is a little larger than the English and German specimens but otherwise indistinguishable.

Trilobosporites apiverrucatus Couper, 1958

Plate 6, figure 15

Diameter: 74 microns

Geologic range: Neocomian to Albian (England), Mannville (Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This species occurs rarely between 170 and 450 feet below the top of the Deer Bay Formation at Buchanan Lake.

It is very common in the Wealden of England.

Trilobosporites canadensis Pocock, 1961

Plate 6, figure 7

Diameter: 84 microns

Geologic range: Valanginian ? (Deville Formation, Alberta)

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This species occurs between 170 and 410 feet below the top of the Deer Bay Formation at Buchanan Lake.

Trilobosporites bernissartensis (Delcourt and Sprumont), 1956

Plate 6, figure 5

Diameter: 70 microns

Geologic range: Purbeckian and Wealden (England and Belgium), Mannville (Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 360 to 370 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Chomotriletes sp. (Naumova), 1953

Plate 6, figure 3

Diameter: 36 microns

Geologic range: Cretaceous (England), Mannville (Alberta)

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Pilosisporites trichopapillosus (Thiergart), 1955

Plate 6, figure 6

Diameter: 56 microns

Geologic range: Wealden (England and Belgium), Neocomian (Ellerslie Formation, Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Aequitriradites spinulosus Pocock, 1960

Plate 6, figure 8

Diameter: 92 microns

Geologic range: Neocomian (Ellerslie Formation).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Gleicheniidites senonicus Ross, 1949

Plate 6, figure 4

Diameter: 26 microns

Geologic range: Jurassic to Cretaceous (Purbeckian and Wealden, England).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Hystrichosphaeridium tubiferum (Ehrenberg), 1934

Plate 6, figure 9

Diameter: 34 microns

Geologic range: Cretaceous (Europe and Mannville of Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This form is a hystrichosphaerid and indicates a brackish to marine condition. Several forms which may represent this species were found at this level but preservation was poor and identification uncertain.

Cicatricosisporites dorogensis Patonie and Gelletich, 1933

Plate 6, figure 10

Diameter: 70 microns

Geologic range: Purbeckian, Wealden and Aptian (England).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This species occurs at several levels in the Deer Bay Formation. Preservation is generally poor.

This specimen is slightly larger than those illustrated by Couper (1958).

Micrhystridium sp. Deflandre, 1937

Plate 6, figure 11

Diameter: 66 microns

Geologic range: Jurassic to Cretaceous.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: This form is thought to have given rise to the hystrichosphaerids. It is a planktonic organism.

Concavisporites parkini Pocock, 1960

Plate 6, figure 13

Diameter: 78 microns

Geologic range: Neocomian to Aptian ? (Mannville Group, Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 360 to 370 feet below top of Deer Bay Formation.

Remarks: Several specimens of this species were found at this level.

Concavisporites verrucosus Delcourt and Sprumont, 1956

Plate 6, figure 13

Diameter: 70 microns

Geologic range: Portlandian to Neocomian (England and Belgium).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 440 to 450 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Parvisaccites radiatus Couper, 1958

Plate 6, figure 14

Diameter: 74 microns

Geologic range: Neocomian to Aptian (England and Mannville of Alberta).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 360 to 370 feet below top of Deer Bay Formation.

Remarks: This form is a pollen grain which has been tentatively assigned to the Coniferae. The figured specimen marks the only occurrence of this species.

Osmundacites primarius (Wolf), 1934

Plate 6, figure 16

Diameter: 46 microns

Geologic range: Upper Jurassic to Lower Cretaceous.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 360 to 370 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Cingulatisporites floridus Balme, 1957

Plate 6, figure 17

Diameter: 80 microns

Geologic range: Kimmeridgian and Portlandian (England)

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 to 570 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Jurassic Dinoflagellates

Scrinodinium apatelum Cookson, 1960

Plate 6, figure 15

Length, 110 microns; maximum width, 82 microns

Geologic range: Oxfordian-Lower Kimmeridgian to Tithonian (England).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 to 570 feet below top of Deer Bay Formation.

Remarks: Several specimens of this species were found at this level. This form is a single celled marine algae and is regarded as an Upper Jurassic index species.

Gonyaulax eumorpha Cookson and Eisenack, 1960

Plate 6, figure 19

Length, 100 microns; maximum width, 84 microns.

Geologic range: Oxfordian-Lower Kimmeridgian to Tithonian.

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 560 to 570 feet below top of Deer Bay Formation.

Remarks: This form is also a single celled marine algae which is regarded as an Upper Jurassic index species.

Palaeozoic Microspores

Triquitrites cf. T. batillatus Hughes and Playford, 1961

Plate 7, figure 1

Diameter: 76 microns

Geologic range: Lower Carboniferous (Spitsbergen).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 170 to 200 feet below top of Deer Bay Formation.

Remarks: Several representatives of this species were found throughout the Deer Bay Formation at Buchanan Lake.

Knoxisporites sp. Potonie and Kremp, 1954

Plate 7, figure 2

Diameter: 100 microns

Geologic range: Pennsylvanian

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 320 to 330 feet below top of Deer Bay Formation.

Remarks: The thick exine of the figured specimen is a striking characteristic of this species.

Endosporites sp. Wilson and Coe, 1940

Plate 7, figure 3

Diameter: 112 microns

Geologic range: Mississippian to Lower Permian (Spitsbergen).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 320 to 330 feet below top of Deer Bay Formation.

Remarks: The figured specimen marks the only occurrence of this species.

Densosporites sp. (Berry, 1937

Plate 7, figure 4

Diameter: 60 microns

Geologic range: Upper Devonian to Pennsylvanian (Soviet Arctic).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 360 to 370 feet below top of Deer Bay Formation.

Remarks: The thick exine of the figured specimen is a striking characteristic of this species.

Cirratriradites sp. (Wilson and Coe), 1940

Plate 7, figure 5

Diameter: 86 microns

Geologic range: Upper Devonian to Pennsylvanian (Soviet Arctic).

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 400 to 410 feet below top of Deer Bay Formation.

Remarks: Several representatives of this species were found in the Deer Bay Formation at Buchanan Lake.

Archaeotriletes sp. (Naumova), 1953

Plate 7, figure 6

Diameter: 70 microns

Geologic range: Upper Palaeozoic

Locality and level of figured specimen: Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada; 400 to 410 feet below top of Deer Bay Formation.

Remarks: Several representatives of this species were found throughout the Deer Bay Formation at Buchanan Lake.

EXPLANATION OF PLATE I

Arenaceous Foraminifera from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island Northwest Territories

Figs. 1 - 4: *Haplophragmoides* sp. B; 1-side view, 2 peripheral view, 3 and 4-side and peripheral views of most common form of preservation x 30 ..... p. 29

Figs. 5 - 6: *Trochammina* sp. D; 5-dorsal view, 6-ventral view, x 80 ..... p. 38

Figs. 7 - 9: *Trochammina* sp. F; 7-dorsal view, 8-ventral view, 9-peripheral view x 80 ..... p. 40

Fig. 10: *Ammobaculites* sp. B; side view x 80 ..... p. 32

Figs. 11-12: *Ammobaculites* sp. D; 11-side view (705'), 12-side view (715') x 30 ..... p. 33

Fig. 13: *Reophax* sp.; side view x 20 ..... p. 27

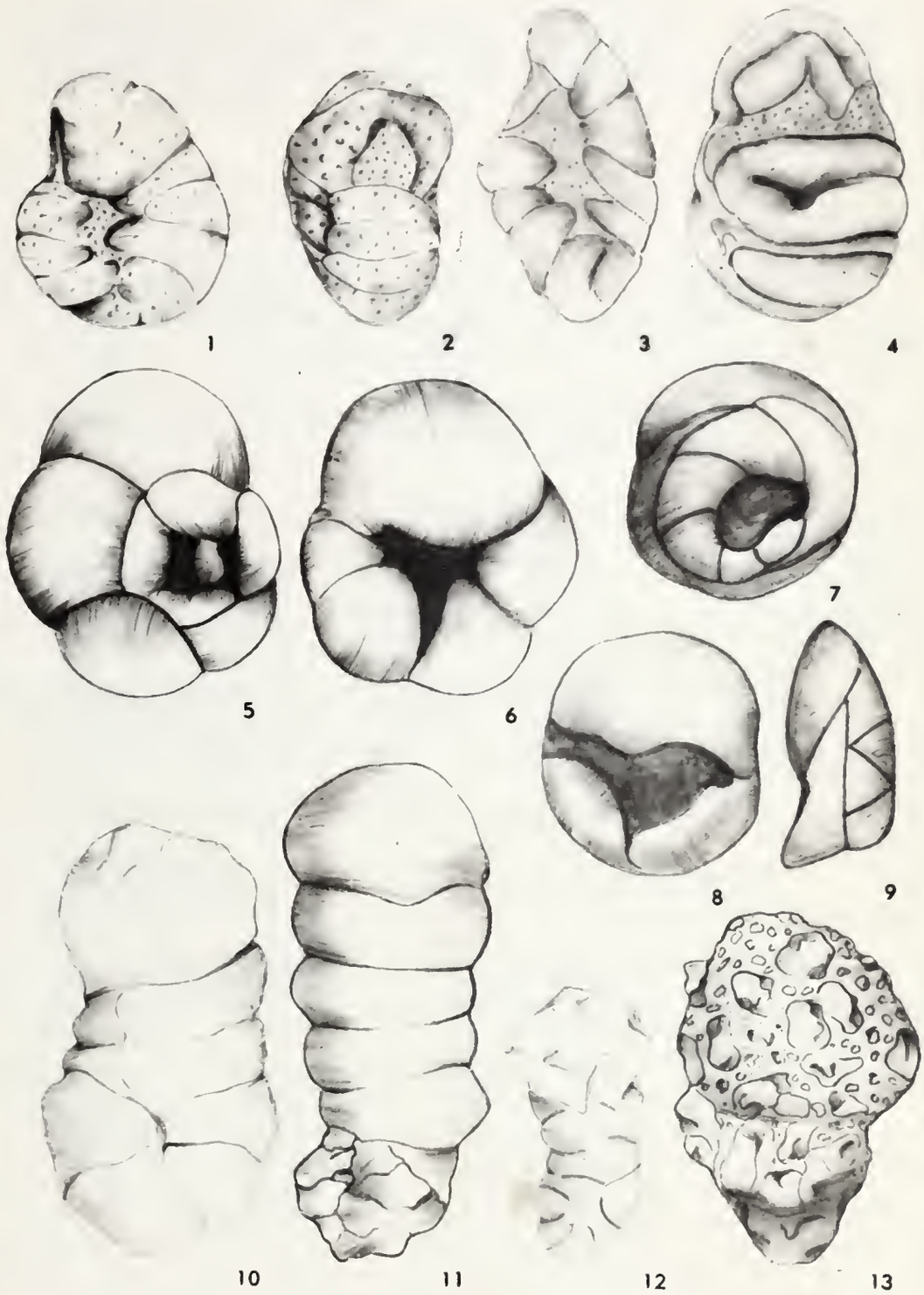


PLATE 1

EXPLANATION OF PLATE 2

Arenaceous Foraminifera from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island Northwest Territories

Figs. 1 - 2: Ammodiscus sp. A; 1-side view, 2-peripheral view x 30 ..... p. 24

Figs. 3 - 5: Haplophragmoides sp. A; 3-side view (involute side) 4-peripheral view, 5-side view (evolute side) x 70 ..... p. 28

Figs. 6 - 7: Textularia sp.; 6-side view, 7-peripheral view x 80 ..... p. 43

Fig. 8: Tritaxia sp.; oblique view x 80 ..... p. 42

Fig. 9: Ammodiscus sp. B; side view x 80 ..... p. 24

Fig. 10: Ammobaculites sp. E; side view x 30 ..... p. 35

Figs. 11-14: Ammobaculites sp. A; 11-side view (evolute side) 12-peripheral view, 13-side view (involute side) 14-apertural view x 80 ..... p. 30

Figs. 15-16: Glomospira sp.; 15-top view, 16-side view x 80 .... p. 26

Figs. 17-19: Ammobaculites sp. C; 17-side view, 18-apertural view, 19-distal view x 80 ..... p. 33

Figs. 20-21: Haplophragmoides sp. C; 20-side view, 21-peripheral view x 70 ..... p. 30

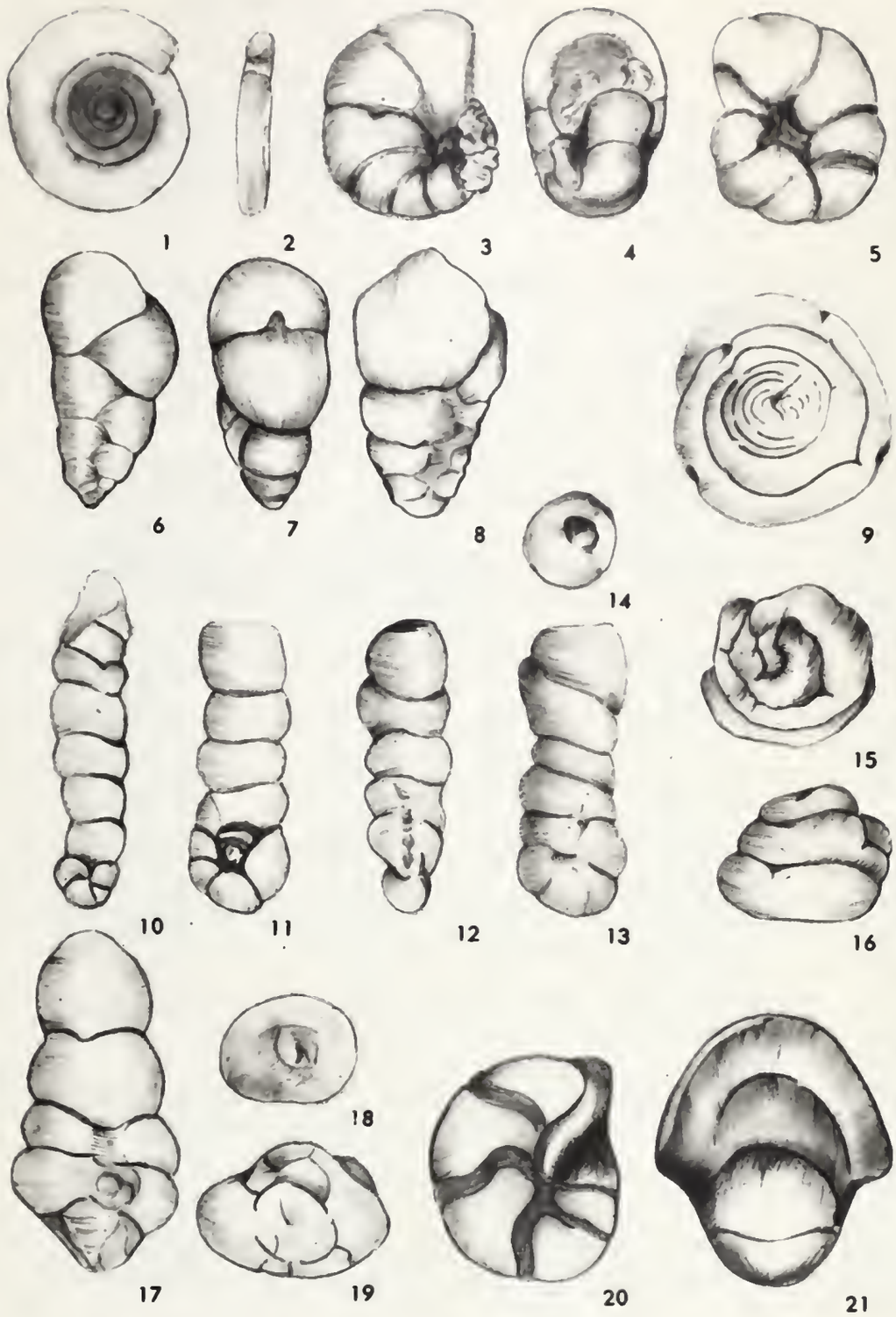


PLATE 2

EXPLANATION OF PLATE 3

Arenaceous and Calcareous Foraminifera
from the Deer Bay Formation, Buchanan Lake,
Axel Heiberg Island and Isachsen, Ellef
Ringnes Island, Northwest Territories.

Figs. 1 - 3: Trochammina sp. B; 1-dorsal view, 2-peripheral view, 3-ventral view x 50 ..... p. 37

Figs. 4 - 6: Trochammina sp. C; 4-dorsal view, 5-peripheral view, 6-ventral view x 30 ..... p. 37

Figs. 7 - 9: Trochammina sp. A; 7-peripheral view (470'), 8-ventral (470'), 9-oblique (450') x 70 ..... p. 36

Figs. 10-12: Trochammina sp. E; 10-dorsal view, 11-peripheral view, 12-ventral view x 80 ..... p. 39

Figs. 13-14: Ammodiscoides sp.; 13-top view, 14-side view x 70.. p. 25

Fig. 15: Nodosaria sp. B; side view x 80 ..... p. 56

Fig. 16: Dentalina sp. B; side view x 30 ..... p. 55

Fig. 17: Dentalina sp. A; side view x 30 ..... p. 54

Figs. 18-19: Verneuilinoides sp.; 18-apertural view, 19-side view x 80 ..... p. 40

Figs. 20-21: Verneuilina sp.; 20-apertural view, 21-side view x 70 ..... p. 41

Figs. 22-23: Marginulinopsis sp.; 22-side view, 23-ventral view x 70 ..... p. 53

Fig. 24: Globulina sp.; side view x 80 ..... p. 57

Figs. 25-26: Vaginulinopsis sp.; 25-apertural view, 26-side view x 70 ..... p. 51

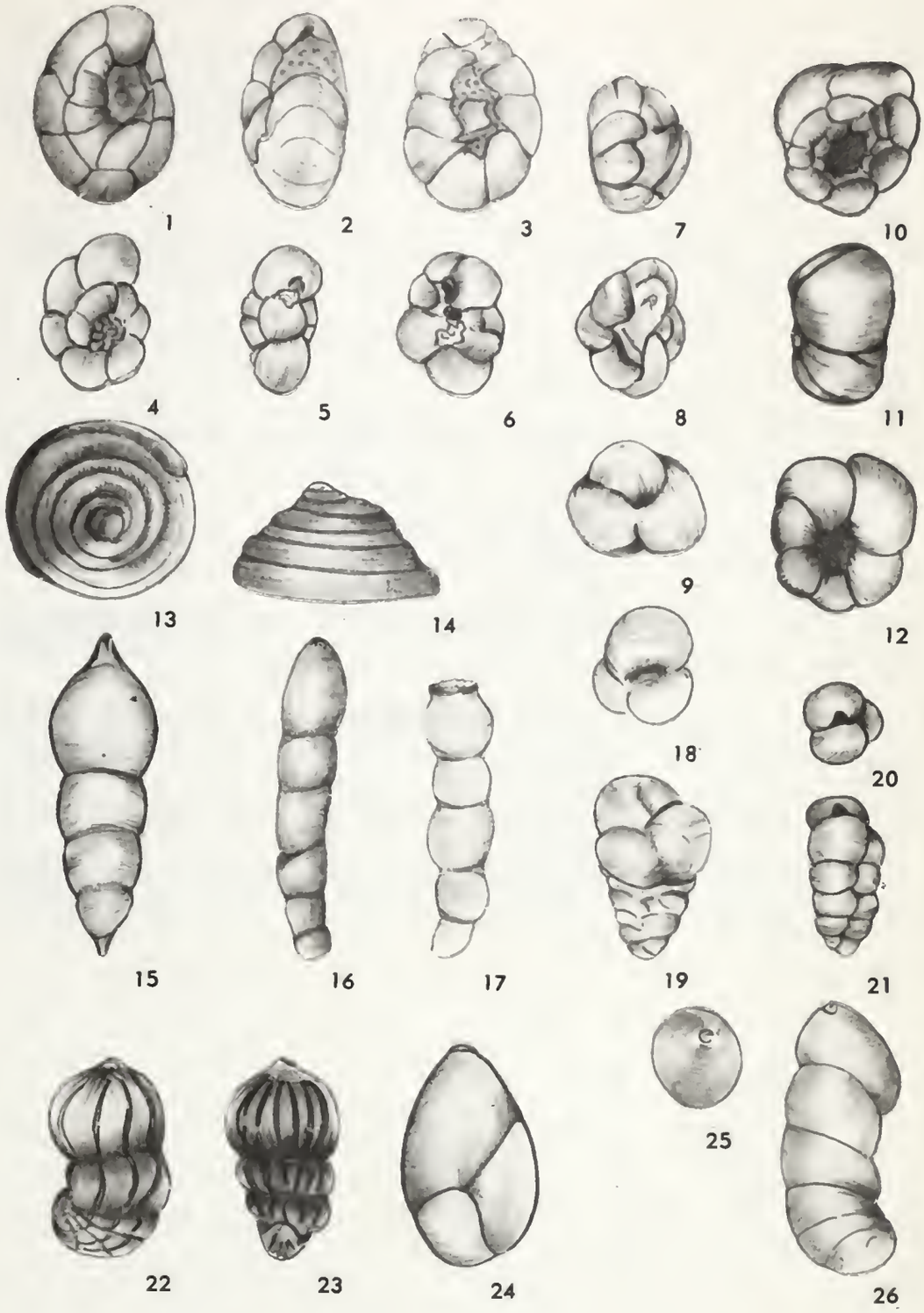


PLATE 3

EXPLANATION OF PLATE 4

Calcareous Foraminifera from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island, Northwest Territories

Figs. 1 - 3: Saracenaria sp. B; 1-side view, 2-ventral view, 3-dorsal view x 70 ..... p. 47

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Figs. 6 - 7: Saracenaria sp. C; 6-side view, 7-ventral view x 80 ..... p. 48

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Figs. 10-11: Lenticulina sp. A; 10-side view, 11-peripheral view x 80 ..... p. 44

Figs. 12-13: Lenticulina sp. D; 12-peripheral view, 13-side view x 80 ..... p. 46

Figs. 14-15: Astacolus sp.; 14-side view, 15-ventral view x 80.. p. 50

Figs. 16-18: Vaginulina sp.; 16-side view (560'), 17-peripheral view (560'), 18-side view (430') x 80 ..... p. 51

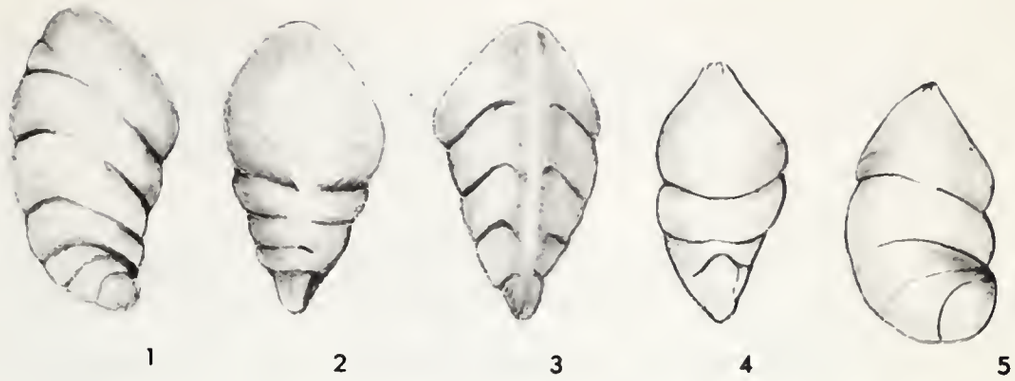


PLATE 4

EXPLANATION OF PLATE 5

Calcareous Foraminifera from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island and Isachsen, Ellef Ringnes Island, Northwest Territories

Figs. 1 - 3: Conorboides sp.; 1-dorsal view, 2-peripheral view, 3-ventral view (showing one aperture), x 80 ..... p. 58

Figs. 4 - 5: Nodosaria sp. A; 4-apertural view, 5-side view, x 50 ..... p. 55

Figs. 6 - 7: Lenticulina sp. B; 6-side view, 7-peripheral view, x 70 ..... p. 45

Figs. 8 - 9: Lenticulina sp. C; 8-side view, 9-peripheral view, x 50 ..... p. 45

Figs. 10-11: Epistomina sp.; 10-peripheral view (showing large auxiliary apertures), 11-dorsal view, x 70 ..... p. 58

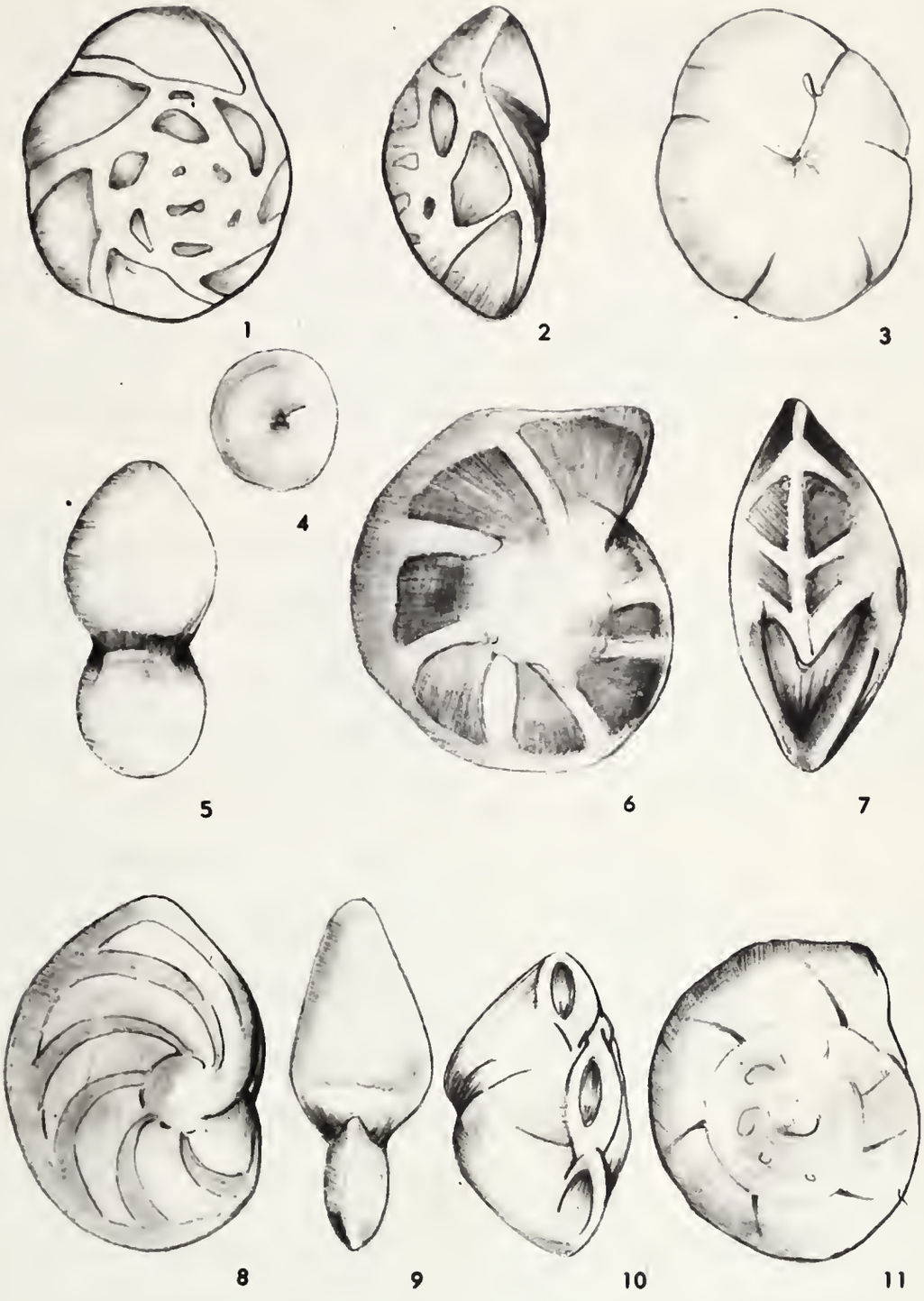


PLATE 5

EXPLANATION OF PLATE 6

Mesozoic Microspores, Hystrichosphaerids, and Dinoflagellates from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island, Northwest Territories. Magnification approximately x 500

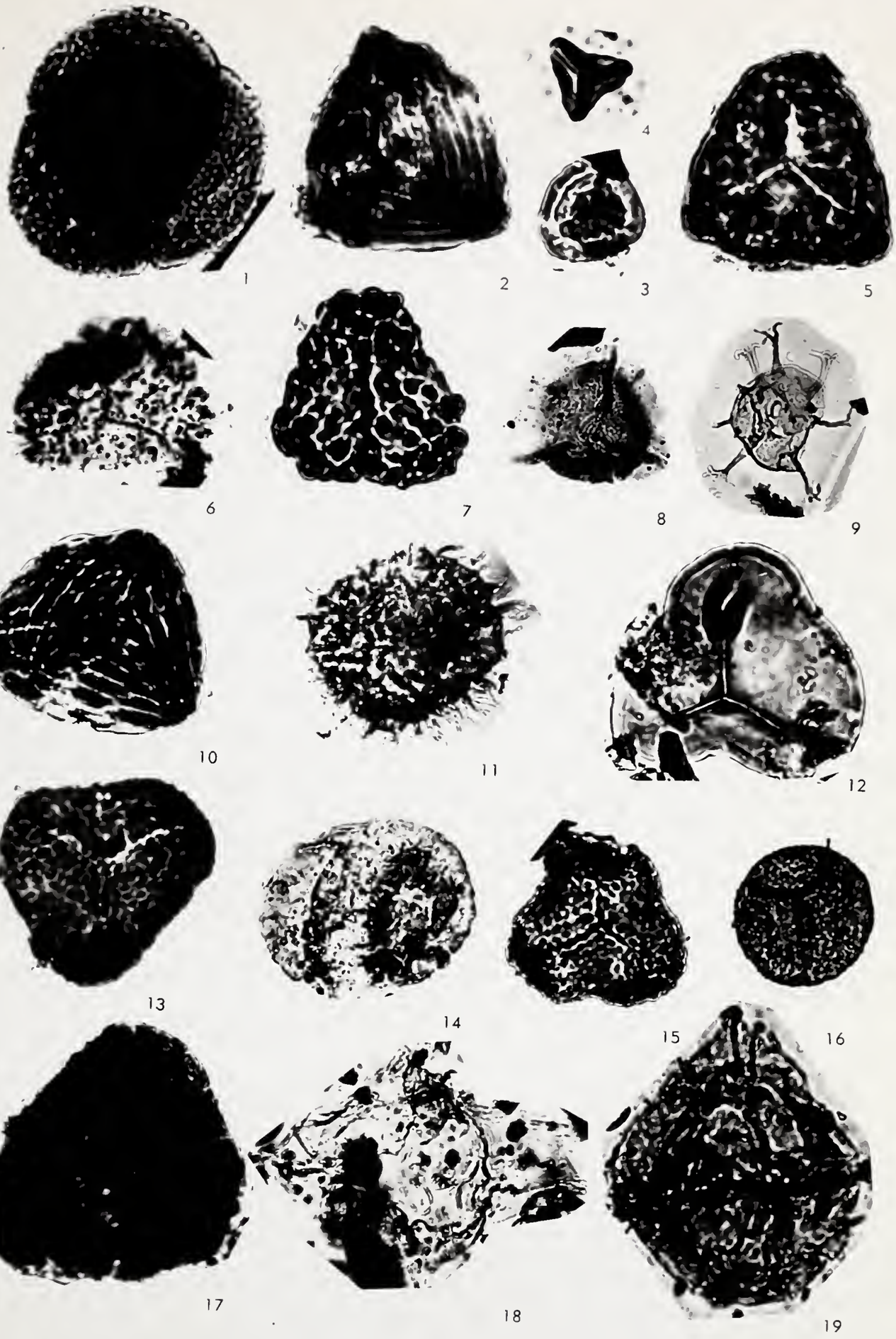
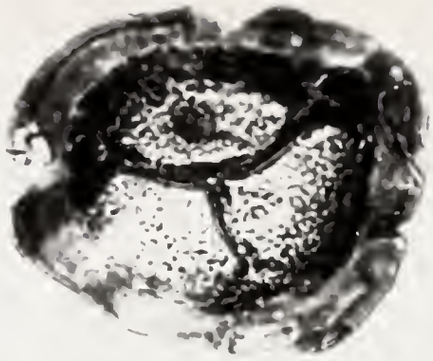


PLATE 6

EXPLANATION OF PLATE 7

Upper Palaeozoic Microspores from the Deer Bay Formation, Buchanan Lake, Axel Heiberg Island, Northwest Territories. Magnification approximately x 500

1



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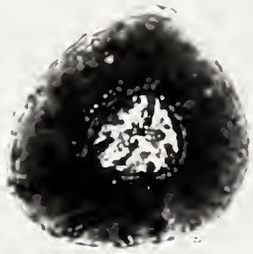

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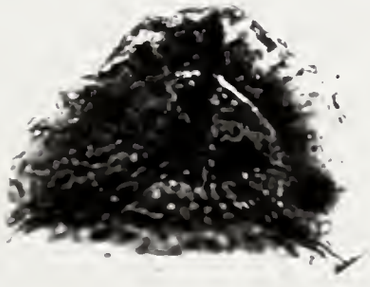

5

6

PLATE 7

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APPENDIX - Part 1

Technical Procedures and Field Work

Shale samples of the Deer Bay Formation were collected by the writer at Buchanan Lake, Axel Heiberg Island, and by geologists employed by J.C. Sproule and Associates Limited at Isachsen, Ellef Ringnes Island.

At Buchanan Lake spot samples were taken at each ten foot interval and at Isachsen, throughout every ten foot interval. At the former locality an attempt was made to collect fresh unweathered material. However, it was found that the depth of weathering was very great. The section at Isachsen was not collected with a view to microfaunal study and the samples are highly weathered. At both localities brief lithological notes were made throughout each ten foot interval and this information was later compiled on standard strip logs. Fifty-four samples were collected at Buchanan Lake and twenty-nine at Isachsen. Every second sample was used for microfaunal analysis from the latter locality.

Preparation was done by placing approximately one hundred grams of each sample into plastic jars containing water and soap. They were then disintegrated by alternate freezing and thawing in a dry ice cabinet and carefully washed and screened through a set of Tyler and Endecotts sieves. The following mesh sizes were found to be the most efficient: 20, 40, 60, 80 and 200.

After screening, the residue in each sieve was placed in a porcelain dish and dried in an oven at about 120°C. They were screened again and

the following mesh sizes were used: 20, 40, 60, 80 and 120. The fractions in each sieve were placed in small paper envelopes.

In the picking process, two spreads were taken for each screen size of every sample to obtain a systematic count of the number of specimens.

Specimens selected for illustration were drawn using a Cooke, Troughton & Simms camera lucida. Each drawing was cut out, placed on white cardboard and photographed at natural size.

In addition, eight samples were chosen for microspore analysis from the Buchanan Lake section. To obtain a greater abundance of specimens, each sample was made up from two samples within a ten foot interval.

After crushing with a hammer, each composite sample was placed in a Neogene bottle and hydrofluoric acid was added to dissolve the silica. Forty-eight hours later they were thoroughly washed and screened through a sieve of 65 mesh. The residue held in the screen was again placed in hydrofluoric acid for forty-eight hours to allow further disintegration. This was then thoroughly washed and screened. The fraction held by the sieve was examined for megaspores.

The material which passed through the sieve during the first screening was oxidized in a solution of nitric acid and potassium chlorate for thirty minutes. This was then thoroughly washed and suspended in potassium carbonate for five minutes to dissolve the humic material. After washing again, the sample was placed in zinc bromide to separate the organic material from the remaining silica. The fraction which remained at the

surface of this heavy liquid after centrifuging was examined under the microscope. In all cases, too much humic material still remained so the samples were oxidized again for one to two hours. After washing, the residue was placed in potassium carbonate for about one minute and then washed. The remaining fraction was placed on a slide and examined for microspores.

Specimens chosen for illustration were photographed with a Zeiss camera microscope. A magnification of either 265x or 128x was used depending upon the spore size. These photographs were enlarged and printed to a magnification of 500x. The pictures were mounted on white cardboard and then rephotographed at natural size.

APPENDIX - Part 2

Description of outcrop samples, Deer Bay Formation, Buchanan Lake, Axel Heiberg Island, Northwest Territories, Canada.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
0 - 170		Covered
	60	Shale - black, fissile, local thin siltstone bands, poor outcrop.
	170	Shale - black, micaceous, silty, hard. Microfauna includes Reophax, Haplophragmoides, Ammobaculites, Lenticulina.
170 - 190		Covered
	190	Shale - black, micaceous, silty, reddish brown weathering. Microfauna includes Haplophragmoides.
190 - 200		Covered
	200	Shale - black, slightly silty, hard, very thin bedded. Microfauna includes Haplophragmoides, Trochammina, Globulina.
200 - 320		Covered
	320	Shale - black, micaceous, silty, local fine-grained sand, hard, medium to dark grey weathering. Microfauna includes Haplophragmoides.
320 - 570		Shale
	330	Shale - black, very silty, little sand. Microfauna includes Reophax, Haplophragmoides, Trochammina.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	340	Shale - as above. Microfauna includes Haplophragmoides.
	350	Shale - black, micaceous, slightly silty, sulfurous in part, grey to black weathering. Microfauna includes Haplophragmoides, Ammobaculites, Globulina.
	360	Shale - black, silty, silty dolomite concretions, phosphate nodules, hard, fractured, dark grey weathering. Microfauna includes Haplophragmoides, Ammodiscus, Lenticulina, Globulina.
	370	Shale - black, slightly silty, hard. Microfauna includes Reophax, Haplophragmoides, Ammodiscus, Ammobaculites, Marginulinopsis, Globulina.
	380	Shale - black, very silty, hard, highly fractured, dark grey weathering. No fossils.
	390	Shale - as above. Microfauna includes Haplophragmoides.
	400	Shale - black, silty, some fine-grained sand, dark grey weathering. Microfauna includes Haplophragmoides, Ammodiscus, Marginulinopsis.
	410	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Lenticulina, Globulina.
	420	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	430	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Lenticulina, Vaginulina, Marginulinopsis.
	440	Shale - black, silty in part, with sandstone concretions, locally sulfurous, dark grey and yellowish brown weathering. Microfauna includes Haplophragmoides.
	450	Shale - as above but less silty. Microfauna includes Haplophragmoides, Ammodiscus, Trochammina, Dentalina, Marginulinopsis, Globulina.
	460	Shale - black, micaceous, slightly silty, soft, sulfurous in part, occasional sandy patches, very rubbly and fractured, dark grey to black weathering. Microfauna includes Haplophragmoides, Ammobaculites, Trochammina, Lenticulina, Saracenaria, Dentalina, Globulina, Nodosaria.
	470	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Trochammina, Marginulinopsis.
	480	Shale - as above. Microfauna includes Reophax, Haplophragmoides, Ammodiscus, Ammobaculites, Trochammina, Lenticulina, Saracenaria, Verneuilinoides, Pseudonodosaria.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	490	Shale - black, slightly silty, locally sulfurous, fractured, dark grey weathering. Microfauna includes Haplophragmoides Ammodiscus, Trochammina, Lenticulina, Saracenaria, Verneuilinoides, Dentalina, Globulina. Megafauna includes Aucella.
	500	Shale - black, micaceous, fissile. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Trochammina, Lenticulina, Globulina, Verneuilinoides.
	510	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Trochammina, Lenticulina, Dentalina, Saracenaria, Vaginulinopsis.
	520	Shale - as above. Microfauna includes Haplophragmoides, Ammobaculites, Trochammina, Lenticulina, Globulina. Megafauna includes Aucella.
	530	Shale - black, micaceous, moderately silty, fissile, fractured, dark grey weathering. Microfauna includes Haplophragmoides, Lenticulina, Saracenaria, Globulina.
	540	Shale - black, micaceous, slightly silty, sulfurous locally, dark grey and yellowish brown weathering. Microfauna includes Haplophragmoides, Ammobaculites, Lenticulina, Saracenaria.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	550	Shale - as above. Microfauna includes Haplophragmoides.
	560	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Verneuilinoides, Lenticulina, Astacolus, Dentalina, Vaginulina, Marginulinopsis, Globulina.
	570	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites, Trochammina, Astacolus.
570 - 695		Covered
	695	Shale - black, micaceous, silty, hard, grey to black weathering. Microfauna includes Haplophragmoides, Ammobaculites.
695 - 925		Shale
	705	Shale - black, micaceous, slightly silty, sulfurous locally, fissile, dark grey and yellowish brown weathering. Microfauna includes Haplophragmoides, Ammobaculites, Verneuilinoides.
	715	Shale - as above. Microfauna includes Ammobaculites.
	725	Shale - black, slightly silty, fissile. Microfauna includes Trochammina.
	735	Shale - black, very silty, hard, dark grey to black weathering. Microfauna includes Haplophragmoides, Ammobaculites.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	745	Shale - as above. Microfauna includes Haplophragmoides.
	755	Shale - as above. Microfauna includes Haplophragmoides.
	765	Shale - black, slightly silty, micaceous fissile, fractured, dark grey weathering. Microfauna includes Ammodiscus.
	775	Shale - as above. Microfauna includes Reophax, Haplophragmoides, Verneuilinoides.
	785	Shale - as above. Microfauna includes Reophax.
	795	Shale - black, slightly silty, hard, micaceous, dark grey weathering. Microfauna includes Haplophragmoides, Ammodiscus.
	805	Shale - as above. Microfauna includes Haplophragmoides.
	815	Shale - as above. Microfauna includes Ammodiscus.
	825	Shale - black, very silty, local fine-grained sand, very soft, medium grey weathering. Microfauna includes Reophax, Haplophragmoides, Ammobaculites.
	835	Shale - black, moderately silty, soft, medium grey weathering. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites.

Interval distance in feet from top of section	Sample point in feet	Description and fauna
	845	Shale - black, moderately silty, fissile, dark grey weathering. Microfauna includes Haplophragmoides, Ammodiscus.
	855	Shale - black, very silty, soft, grey weathering. Microfauna includes Haplophragmoides, Ammodiscus.
	865	Shale - black, micaceous, slightly silty, local thin silty dolomite beds, medium to dark grey and locally reddish brown weathering. Microfauna includes Ammodiscus.
	875	Shale - as above. Microfauna includes Haplophragmoides, Ammodiscus, Ammobaculites.
	885	Shale - black, very sandy, soft, grey weathering. Microfauna includes Haplophragmoides.
	895	Shale - as above. Microfauna includes Haplophragmoides.
	905	Shale - as above. Microfauna includes Haplophragmoides.
	915	Shale - as above. Microfauna includes Haplophragmoides.
	925	Shale - black, very sandy, sulfurous, soft, medium grey weathering. Microfauna includes Haplophragmoides.

Contact with Awingak Formation; conformable and gradational through five to ten feet.

Part 3

A list of illustrated microspores and intervals in which they were found from the Deer Bay Formation, Axel Heiberg Island, Northwest Territories, Canada.

Interval distance in feet from top of section	Flora
170 - 200	Ricciisporites convolutus, Appendicisporites tricornatus, Trilobosporites apiverrucatus, T. canadensis, Chomotriletes sp. Pilosporites trichopapillosus, Aequitriradites spinulosus, Gleicheniidites senonicus, Hystrichosphaeridium tubiferum, Cicatricosisporites dorogensis.
320 - 330	Knoxisporites sp., Aequitriradites sp., Endosporites sp.
360 - 370	Concavisporites parkini, Trilobosporites canadensis, T. bernissartensis, Parvisaccites radiatus, Cingulatisporites floridus, Osmundacites primarius, Couperisporites complexus.
410 - 400	Trilobosporites apiverrucatus, T. canadensis, Ricciisporites convolutus.
440 - 450	Concavisporites verrucosus
560 - 570	Cicatricosisporites dorogensis, Scrinodium apatelum, Cinqulatisporites floridus, Gonyaulax eumorpha

Part 4

Field lithology descriptions of the Deer Bay Formation at Isachsen, Ellef Ringnes Island were unobtainable. Samples used for microfaunal analysis were highly weathered and crumbly. The following is a very general description of the section.

The Deer Bay Formation at Isachsen, Ellef Ringnes Island is similar to the section at Buchanan Lake, Axel Heiberg Island. It consists of black, silty to sandy fossiliferous shale with local thin, hard, dense limestone bands. In the lowermost beds concretionary zones are well developed. These concretions are composed of fine-grained, well cemented dense sandstone and ironstone with fossil nuclei.

The contact with the overlying Isachsen Formation is gradational through five to ten feet and conformable. The lower contact with the Awingak Formation is not exposed but is presumed to be gradational and conformable.

The following is a list of the fauna obtained at each sample interval.

Interval distance in feet from top of section	Fauna
0 - 10	Haplophragmoides, Ammobaculites
20 - 30	Haplophragmoides, Ammobaculites, Ammodiscus, Globulina
40 - 50	Ammobaculites
70 - 80	No fossils

Interval distance in feet from top of section	Fauna
255 - 262	Haplophragmoides, Textularia, Epistomina
268 - 278	Haplophragmoides, Ammodiscus, Glomospira
288 - 298	Haplophragmoides, Ammobaculites, Trochammina, Verneuilinoides, Globulina
308 - 318	Haplophragmoides, Glomospira
328 - 338	Haplophragmoides, Ammobaculites, Tritaxia, Trochammina, Verneuilinoides
355 - 357	Haplophragmoides, Ammodiscus, Textularia, Tritaxia, Trochammina, Glomospira, Verneuilinoides, Globulina
370 - 380	Haplophragmoides, Ammobaculites, Tritaxia, Trochammina, Glomospira, Conorboides
390 - 400	Haplophragmoides, Ammobaculites, Ammodiscus, Tritaxia, Trochammina, Verneuilinoides, Lenticulina, Conorboides
410 - 420	Haplophragmoides, Ammobaculites, Tritaxia, Trochammina, Glomospira, Globulina, Conorboides
430 - 440	Haplophragmoides, Conorboides, Nodosaria
450 - 451	Haplophragmoides, Ammobaculites, Glomospira, Globulina, Lenticulina, Conorboides.
451 - 464	Haplophragmoides, Ammobaculites, Tritaxia, Trochammina, Glomospira, Verneuilinoides, Lenticulina, Marginulinopsis, Eponides, Conorboides
474 - 484	Haplophragmoides, Ammobaculites, Trochammina, Verneuilina, Globulina, Lenticulina, Marginulinopsis, Epistomina, Conorboides
494 - 504	Haplophragmoides, Ammobaculites, Trochammina, Conorboides
514 - 524	Haplophragmoides, Trochammina, Verneuilina, Conorboides

Part 5

At the following intervals these macrofossils were found in the Deer Bay Formation at Isachsen:

290 - 350	Aucella, Acroteuthis, Arctica, Leptosolenia
370 - 450	Acroteuthis
453 - 464	Aucella, Terebratula, Ostrea, Acroteuthis, Pterolytoceras, Homolsomites (Neocraspedites)